JOURNAL of the Bombay Natural History Society

Vol. 76, No. 1

Editors : J. C. Daniel, P. V. Bole & A. N. D. Nanavati

APRIL 1979 Rs. 35

NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8.20 × 5.60 cm (No. 2 Brownie) and on glossy glazed paper.

6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name, with the abridged titles of journals or periodicals underlined (italics) and titles of books *not* underlined (roman type), thus:

Banerji, M. L. (1958): Botanical Exploration in East Nepal. *J. Bombay nat. Hist. Soc.* *55*(2):243-268.

Prater, S. H. (1948): The Book of Indian Animals. Bombay. Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Banerji 1958).

9. *Synopsis*: Each scientific paper should be accompanied by a concise, clearly written synopsis, normally not exceeding 200 words.

10. *Reprints*: Authors are supplied 25 reprints of their articles free of charge. In the case of joint authorship, 50 copies will be given gratis to be distributed among the two or more authors. Orders for additional reprints should be in multiples of 25 and should be received within two weeks after the author is informed of the acceptance of the manuscript. They will be charged for at cost plus postage and packing.

11. The editors reserve the right, other things being equal, to publish a member's contribution earlier than a non-member's.

Hornbill House,
Shahid Bhagat Singh Road,
Bombay 400 023.

EDITORS,
Journal of the Bombay Natural History Society.

VOLUME 76 (1) : APRIL 1979

Date of Publication : 12-2-1980

CONTENTS

BIRDS: 6. Occurrence of chestnutheaded bee-eater (*Merops leschenaulti*) in Bombay. By P. Kannan and G. Bertrand (p. 157); 7. Beehive predation by wasps (Genus *Vespa*) and its possible benefit to honeyguides (Indicatoridae) in Bhutan. By S. A. Hussain and Sálim Ali (p. 157); 8. A note on the predation of jungle myna (*Acridotheres fuscus* Wagler) on field mouse. By A. J. T. Johnsingh (p. 159); 9. The nesting of tickell's flycatcher (*Muscicapa tickelliae*) in Bombay. By Humayun Abdulali (p. 159); 10. New records of birds from Orissa. By N. Majumdar (p. 161).

REPTILES: 11. Captive rearing of marine turtles. (*With two plates*). By Romulus Whitaker (p. 163); 12. Malformation at birth in the saltwater crocodile (*Crocodylus porosus* Schneider) in Orissa, India. By S. K. Kar (p. 166); 13. Sexual attraction of a wild mugger (*Crocodylus palustris* Lesson) toward captive muggers. (*With three text-figures*). By Lala A. K. Singh (p. 167); 14. Winter temperature gradient in tunnels of *Uromastyx hardwickii* Gray. By R. K. Bhatnagar, R. K. Bhanotar, Y. Mahto and Y. N. Srivastava (p. 172); 15. Identification of snake skins. (*With two plates*). By K. Viswanathan (p. 173).

AMPHIBIA: 16. Food of *Rana hexadactyla* Lesson. By M. I. Andrews (p. 175).

FISHES: 17. On the breeding behaviour of *Schizothorax niger* Heckel in Dal Lake. (*With a text-figure and a photograph*). By K. K. Vass, H. S. Raina and Shyam Sunder (p. 179).

INSECTS: 18. A note on the zoogeography of Indian Meloidae (Coleoptera). By R. K. Anand and Swaraj Ghai (p. 184); 19. On some insects associated with Lac in India. By R. S. Gokulpure, B. P. Mehra, P. Sen and Jawahir Lal (p. 185); 20. A flourishing colony of *Coptotermes heimi* (Wasm.) (Insecta: Isoptera) in a Naval Boat. By M. L. Thakur and P. K. Sen-Sarma (P. 188).

CRUSTACEA: 21. On the eulittoral Palaemonid Shrimp (Crustacea, Decapoda) of Visakhapatnam coast. (*With a text-figure*). By K. Ravindranath (p. 189).

OLIGOCHAETA: 22. First record of *Lumbricus castaneus* (Savigny) from India (Lumbricidae: Oligochaeta). By J. M. Julka (p. 191).

SPONGES: 23. Faunal associations of littoral sponges in and around Balugaon in Chilka lake (Lagoon). By A. L. N. Sarma, D. G. Rao and S. Satapathy (p. 192).

BOTANY: 24. The broadcasting of Karvi seed. By D. J. Panday and J. D. Panday (p. 195); 25. The genus *Amomum* Roxb. (Zingiberaceae) in Andaman and Nicobar islands. (*With two plates*). By N. P. Balakrishnan and N. G. Nair (p. 196); 26. Record of *Hyptis capitata* Jacq. (Labiatae) from Peninsular India. (*With a text-figure*). By T. G. Varghese (p. 200); 27. A new distributional record for *Distemon indicum* Wedd. from Tehri Garhwal. By Shiv Kumar Dhyani (p. 200); 28. On the occurrence of *Gymnema cuspidatum* (Thunb.) K. Schum. (Asclepiadaceae) in Maharashtra. (*With six text-figures*). By S. K. Malhotra, K. Madhusudan Rao and B. G. Kulkarni (p. 202); 29. An intersting grass from Maharashtra. (*With twelve text-figures*). By U. R. Deshpande and N. P. Singh (p. 204); 30. Some interesting plant records for Rajasthan. By V. Singh (p. 206); 31. Some new plant records of Nagpur region. By S. A. Paradkar and S. K. Munshi (p. 209); 32. Notes on two interesting sedges from Gujarat State, India. (*With a plate*). By S. D. Sabnis and J. V. Joshi (p. 210); 33. New records of plants from Andaman and Nicobar Islands. By Paritosh Chakraborty (p. 212); 34. Filamentous Myxophyceae of Aurangabad District, Maharashtra. By P. V. Ashtekar and N. D. Kamat (p. 215).

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1979 APRIL | Vol. 76 | No. 1

BEHAVIOUR OF HOOLOCK GIBBON (*HYLOBATES HOOLOCK*) DURING DIFFERENT SEASONS IN ASSAM, INDIA[1]

RONALD L. TILSON[2]

(*With three figures*)

A small population of hoolock gibbons (*Hylobates hoolock*) was observed during 62 days between July 1971 and February 1973 at Hollongapar forest reserve in upper Assam. Social structure among seven groups consisted of a monogamously mated pair of adults with 0-3 offspring (mean size = 3.4). These family groups occupy territories of about 22 ha (range = 18-30 ha) which overlap by 23 per cent the space of adjacent families. Fruit is a preferred food item, constituting 67 per cent of their diet in winter, with leaves and insects contributing 32 and 1 per cent, respectively. On cold winter mornings gibbons climb into special trees and sunbathe (mean = 92 min) before feeding. They sunbathe less frequently (56 per cent of mornings) and for shorter periods (mean = 26 min) during the warmer summer. Infants are born during the dry winter months, perhaps to synchronize early gestation and lactation with the monsoon. Differences in behaviour between summer and winter periods are discussed relative to other gibbon species occupying equatorial forests.

INTRODUCTION

In 1930 McCann (1933) spent two months collecting and observing hoolock gibbons (*Hylobates hoolock*) at Changchang Pani in the Naga Hills of Assam. He established that they live in monogamous family groups and that the dichromatism of the species is determined by sex and age rather than individual variation. The only food habit study on *H. hoolock* reports that certain leaves and fruits were selected by captive animals as principal dietary items (Candler 1904). Except for these brief observations by McCann in the field and Candler in a zoo, there is no other information available on the behaviour and ecology of hoolock gibbons.

[1] Accepted July 1977.

[2] Division of Environmental Studies, University of California, Davis 95616. U.S.A.

Gibbons are small arboreal apes that range from the Brahmaputra River in Assam, east to Indochina and south through Malaya into the Indonesian archipelago. Of the nine recognized species (Groves 1972), six occur in equatorial rain forest where forest phenology can be aperiodic and largely unpredictable (Richards 1966, McClure 1966, Medway 1972). with few exceptions, the equatorial species of Malaysia and Indonesia have been studied extensively and thus form the basis from which gibbon ecology is extrapolated (Ellefson 1974, Chivers 1974, Tenaza 1975, Rodman *in press*).

In contrast, observations of gibbon species occupying more northern latitudes by McCann (1933) in Nagaland and Carpenter (1940) in Changrai, Thailand, were too brief to reveal any influence of seasonality. In Assam, India, the hoolock gibbon lives in evergreen rain forest between latitudes 22° and 28° north. Here seasonality is more pronounced, with two dissimilar seasons, the warm wet summer and cold dry winter. Behavioural responses of hoolock gibbons to these different environments are presented.

Habitat and methods

Study Area

A small viable population of hoolock gibbons was found in Hollongapar Forest Reserve 12 km south of Jorhat, Sibsagar District (26°70′N, 94°30′E), upper Assam (Fig. 1). The forest boundary encompasses 1,900 ha, but selective timbering has reduced the habitat suitable for gibbons to about 800 ha. The flat lowland forest (altitude 119 m) is intersected by numerous streams that flood during the monsoon but otherwise are dry. Ground water is available throughout the year in small isolated pools. A railroad track runs through the southern section, and two roads divide the forest into four unequal quadrats. The reserve is surrounded by extensive tea gardens, creating a forest island.

The vegetation is evergreen forest dominated by *Dipterocarpus macrocarpus*, *Shorea assamica* and *Mesua terra* (Champion 1936). Irregular clumps of bamboo (*Bambusa* and *Dendrocalamus* spp.) and cane (*Calamus* spp.) are common. The forest structure is three-storied with a continuous canopy (except over the main trails and railway track) rising to a mean height of 15-22 m.

The seasons in Assam are distinct. Das (1970) compiled 20-year records from the *Indian Meteorological Memoirs* for Assam, and data from the Hollongapar area are extrapolated and presented here. The summer from June to September is monsoon, with high temperatures (mean = 27.4°C) and heavy rains (mean = 38.9 cm/month). Nearly 63 per cent of the total rainfall in Hollongapar (annual mean = 249 cm) occurs during the monsoon. The winter from December to February is marked by low temperatures (mean= 10.1°C) and little rainfall (mean = 3.2 cm/month). Winter fogs are common in Assam, with Hollongapar receiving an average of 44 foggy days annually. Elsewhere in Assam different weather regimes prevail, leading to plant associations other than evergreen rain forest (Champion & Griffith 1948).

Three other primate species, two macaques and one langur, also occur in Hollongapar forest. One group of about 26 pigtail macaques (*Macaca nemestrina*) and three groups of rhesus macaques (*Macaca mulatta*), averaging about 20 animals each, were encountered daily. The multimale bisexual groups of capped langurs (*Presbytis pileatus*) of 18 and 27 animals and one all-male group of 11 were counted.

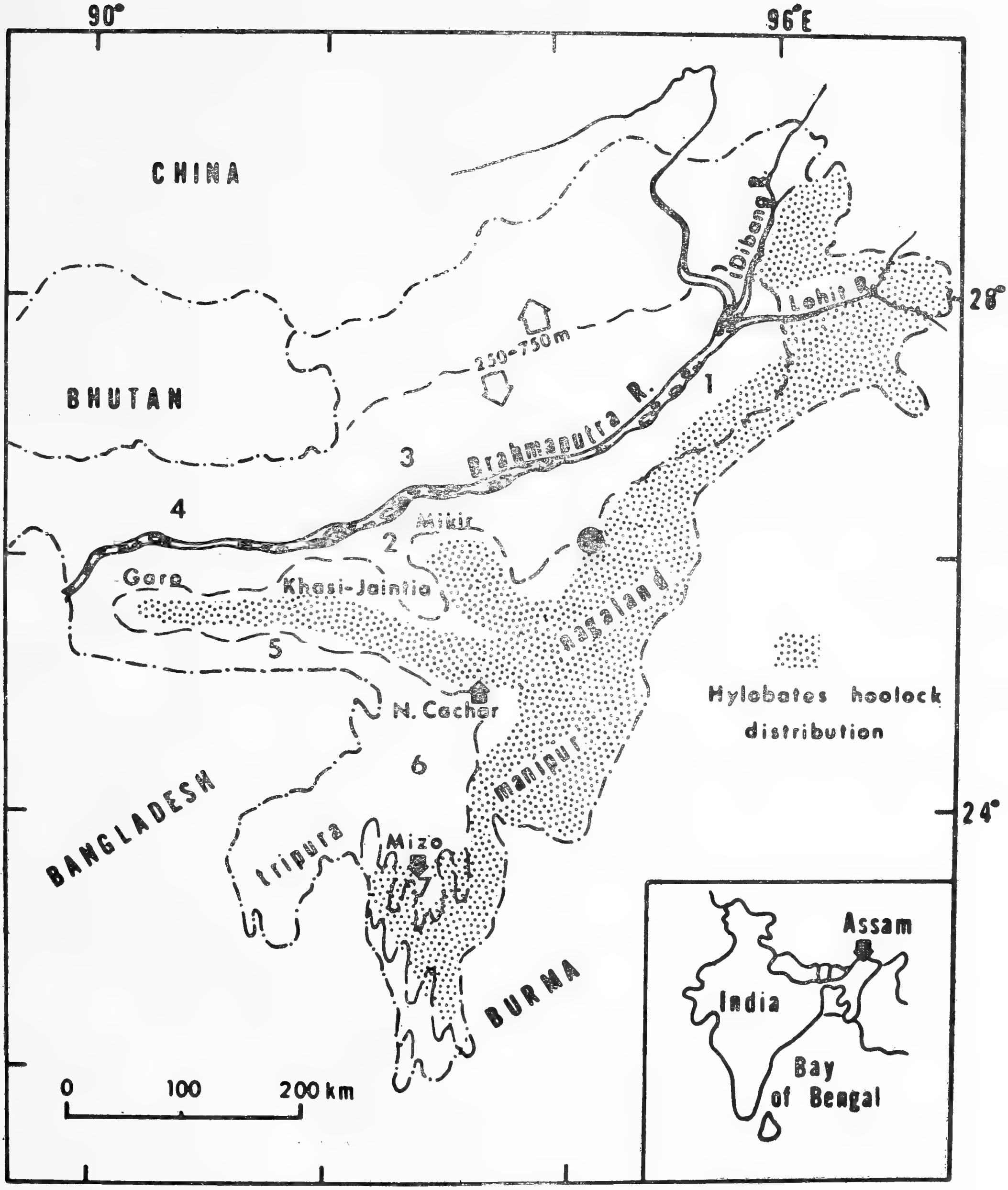


Fig. 1. The distribution of hoolock gibbons in Assam. Numerals refer to the seven natural regions: 1) Upper Assam Plains, 2) Central Assam Plains, 3) North Bank Plains, 4) Lower Assam Plains, 5) Meghalaya, 6) Barak Plain, 7) Mizo Hills. The closed circle indicates the locality of Hollongapar Forest and the dotted line indicates the transition zone between 250-700 m elevation above sea level. The Brahmaputra River lies between 134 m to 50 m elevation.

Areas Surveyed

I spent six weeks censusing anthropoid primates in Assam from July to August, 1971, and November to February, 1972-73. Forested areas in Meghalaya (Garo Hills, United Khasi-Jaintia Hills), the Central Assam Plains (Mikir Hills, North Cachar Hills) and the Upper Assam Plains were visited. The Lower Assam and North Bank Plains north of the Brahmaputra River were included (Fig. 1). District Forest Officers in these areas were interviewed. If gibbons were reported to occur I attempted to find them. Visual or aural contact with gibbons were the only criteria acceptable. Sex and age of all group members was determined when possible. In many cases no gibbons could be found at sites where they apparently once occurred. Their absence is attributed to extensive timbering that has left many areas devoid of any real forest.

Methods

Three gibbon families were studied for 62 days in Hollongapar forest. The summer period was 34 days (2 July—4 August), and the winter period was 28 days (10-28 November, 4-12 January). This forest has been protected from human predation since 1924, and the gibbons lacked the avoidance response common to most wild species. Within a week I could approach three families to within 25 m, which facilitated dawn to dusk observations. When a gibbon group was sighted, its location and direction of movement were referenced to the nearest trail-marker, spaced every 25 m along the main trails. These data were then transferred to a Forest Department map of Hollongapar drawn on a 1 : 1,000 scale. Song sites and intergroup interactions were also mapped. I recognized groups from their location and composition. The onset time, duration and location of all gibbon songs were noted on a 24 h basis. Gibbon song sites beyond my view were determined by taking a compass reading and estimating the distance from two separate locations at least 100 m apart. The two readings were then triangulated. This method proved to be accurate to within 25 m at distances of less than 500 m. Songs were recorded for later analysis at 19 cm/sec with a Uher 4,400 tape recorder and an AKG D-160 microphone fitted to a 60 cm parabola. Focal animal observations were used when the gibbons were feeding. Each minute the category of food was noted, and after the group left a sample was collected and later identified by A. K. Barbaruh, a silviculturist stationed at Hollongapar. Other social interactions were recorded briefly or checked on prepared lists which I transcribed and expanded each evening.

RESULTS

Distribution

H. hoolock once ranged throughout much of what is now Assam, Burma, Bangladesh and parts of southern China (Pocock 1941, Fooden 1969, Groves 1967). Its northernmost range is known to have been north of the Sadiya Frontier Tract in Assam (about 28°N, 96°E) between the Lohit and Dibang Rivers (Parsons 1940, 1941), Goletu (27°37′N, 97°54′E) in upper Burma (Pocock 1941) and an unknown distance into western Yunnan (Homo-shu-Pass: 25°00′N, 98°45′E) of China (Anderson 1878, Andrews and Andrews 1918, Fooden 1969, Groves 1967). Parsons (1940, 1941) established that the Brahmaputra, Lohit and Dibang Rivers in the Upper Assam Plains are the western limits to the range of *H. hoolock*. The eastern limit, once thought to be the Irrawaddy River in

Burma (Candler 1904), is now put at the Salween River (Groves 1967), the western limit of the white-handed gibbon *H. lar* in Thailand (Marshall *et al.* 1973). The southern range passes through the Chittagong Hill Tracts of Bangladesh and south as far as Gokteik, Shan States (22°21′N, 96°55′E) of southwest Burma (Anderson 1878, Groves 1967).

The present distribution of *H. hoolock* has been reduced considerably. One hundred years ago gibbons were common in the Chittagong Hill Tracts of Bangladesh (Anderson 1878, Mountfort 1969), but a reconnaisance by R. Tenaza in 1971 found intensive deforestation has decimated these populations (R. Tenaza, personal communication). The 1935 Vernay-Hopwood Chindwin expedition to northern Burma provides the only available knowledge on *H. hoolock* in Burma (Carter 1943). Gibbons were observed and collected along both banks of the Chindwin River from Homalin to Dalu at altitudes up to 1,280 m (Carter 1943). Today the greatest concentrations of *H. hoolock* in India are in the Upper Assam Plains (Lakhimpur and Tirap) where major stands of evergreen rain forest still occur. Elsewhere in the Mikir and North Cachar Hills, the Garo Hills and the United Khasi-Jaintia Hills evergreen and mixed evergreen forest persists in the higher altitudes (200-750 m), and gibbons occur but only as isolated and scattered populations (Table 1, Fig. 1).

TABLE 1

DISTRIBUTION OF TROPICAL EVERGREEN FOREST AND GIBBON (*H. hoolock*) POPULATION SIZE IN ASSAM, INDIA.

	Forest Area[1] (sq. km)	% of Total area	No. of Gibbon Groups — Individuals[2]
Upper Assam Plain (Sibsagar Only)	3,780	15.2	8,310 — 26,600
Central Assam Plain	920	16.4	2,020 — 6,400
Lower Assam Plain	3,480	15.6	0[3]
North Bank Plain	1,560	17.9	0[3]
Meghalaya	3,480[4]	9.3	7,650 — 24,500
Barak Plain	2,380	89.1	5,230 — 16,700
Mizo Hills	650	—	1,430 — 4,500
Total	16,250[5]	—	24,640 78,700

[1] Forest data from the Statistical Handbook of Assam, Shillong. 1961-62 (Das 1970).

[2] These figures, based on values determined in censuses (1971-72) are an approximate assessment of gibbons in Assam. Family groups have a mean size of 3.2 individuals (n = 24) with 2.2 groups per 1 km.[2] These figures are for complete occupancy in available space and thus represent the maximum population size.

[3] Gibbons do not occur north of the Brahmaputra River.

[4] The United North Cachar and Mikir Hills constitute 80% of this figure, the Garo Hills and Khasi-Jaintia Hills 5% and 15% respectively.

[5] No figures are available for Tripura, Manipur, Nagaland or NEFA. Reserved forest constitutes 11.7 per cent of the total land in Assam, with 11,200 km^2 suitable for gibbons. See Fig. 1 for locations.

Among the five forest types distinguished in Assam (Champion & Griffith 1948), only evergreen and mixed evergreen rain forest appear suitable for gibbons. Forest types in Assam are correlated with the prevailing weather regimes; evergreen forest does not grow in areas with less than 200 cm of rain per year (Champion & Griffith 1948). Evergreen forest is the dominant forest type in the districts of Sibsagar, Lakhimpur, Nagaland and Manipur, but the last three areas are restricted and could not be surveyed. The increasing population pressures, expanded settlements and continuous *jhumming* or "slash and burn" agriculture is reported to have eliminated much of the tall forest in these areas (Das 1970). Since 1835 the human population of Assam has swollen from 800,000 to over 16 million (Das 1970). This enormous increase in human population is incompatible with the preservation of pristine forest; in turn, the exclusively arboreal Indian ape is rapidly running out of suitable habitat.

TABLE 2

COMPOSITION, AGE AND SIZE OF GIBBON FAMILIES IN HOLLONGAPAR FOREST.

Group	Adults (8 yrs)	Subadult (6-8 yrs)	Adolescent (4-6 yrs)	Juvenile (2-4 yrs)	Infant (< 1 yr)	Total
1	M — F	—	—	M	—	3
2	M — F	—	—	—	1	3
3	M — F	—	F	—	1	4
4	M — F	—	—	—	1	4
5	M — F	M	—	F	1	5
6	M — F	—	M	—	—	3
7	M — F	—	—	—	—	2

Sex is indicated by the symbols M (male) and F (female) and if undetermined a numeral is used. The approximate age of individual social classes is indicated (Ellefson 1974, and from personal observation). Mean size for the seven groups is 3.4 ± 0.9 individuals.

Social Organization

Seven gibbon groups observed in Hollongapar forest and 17 other groups counted elsewhere in Assam were comprised of an adult pair with one to four immature offspring. Mean size for the 24 groups was 3.2 ± 0.8 animals (range = 2-6). The spacing of offspring in these family units indicates that infants are born approximately every 2-3 years (Table 2). The extraordinary reproductive rate of a pair of hoolock gibbons introduced into the Mahandi Wildlife Sanctuary near Darjeeling, where four infants have been born in four years, is unprecedented (Anonymous 1972). McCann (1933) first documented monogamy in *H. hoolock*. Numerous subsequent studies (Carpenter 1940, Brockelman *et al.* 1973, Ellefson 1974, Chivers 1974, Tenaza 1975), including the present one, confirm that all gibbon species are monogamous.

Three solitary individuals were encountered. Two were fully grown males that were not attached to any known group. Their glossy pelage, full canines, and solitary status indicate they were excluded from their natal groups and were not senile remnants of a mated adult pair. Because they were seen to travel through 2-3 established territories, did

not sing and avoided other groups, they were assumed not to be territorial. Such floating males are characteristic of vertebrate populations in which all habitat suitable for breeding is held by territorial animals (Brown 1969). All of Hollongapar forest was not evaluated as to gibbon occupancy, but the 200 ha in which these observations were made was fully occupied by mated pairs.

A solitary subadult female was seen on several occasions. Her fur was just beginning to turn from juvenile black to the buff colour that characterized adult females (McCann 1933). I followed the subadult female for three consecutive days. Each night she slept in a tree that was over 1,000 m from the tree she slept in the night before, crossing through 3-4 established territories. When a distant pair of gibbons began to call (morning songs are audible up to 800 m), she immediately stopped feeding and began moving in their direction. If a closer pair joined the chorus she changed direction and moved towards them, but contact was never established.

One of the seven gibbon families in Hollongapar included a sub-adult male that was fully grown but dominated by the group's adult male. He lingered behind the adults in group progressions, and his only close physical contact was with a younger sibling that he often approached and sat with. Whenever he attempted to enter a tree the adults were in, the adult male vigorously shook the branch he was on or rushed towards him. Either action caused the young male to depart. No aggression was recorded from the adult female.

Songs

Candler (1904) and McCann (1933) both have described phonetically the song of the hoolock gibbon. The song is an elaborate duet between the adult pair. Young offspring of both sexes may also sing with the adults. The adult male initiates the song with a single high note given two to three tiimes in succession. If the female does not respond he repeats the series. These introductory notes, audible to about 100 m, are not given by immature offspring. Hoolock gibbon songs do not have a phase of progressive elaboration. Instead, the song includes an accelerated passage of alternating high and low notes reminiscent of the siamang (*H. syndactylus*), except the base line harmonics gradually ascend (Marshall & Marshall 1976). The song is unusual among gibbons in that there is no clear sexual dimorphism in calls. Marshall & Marshall (1976) heard a single female at the Calcutta zoo render the entire song as a solo.

Hoolock gibbon songs last for about 15 min (mean = 14.4 $\pm$ 6.1 min; range = 4-32 min, n = 114). An adult pair usually sings once daily; sometimes they sing a second time (12% of total calls). Songs were given on 87 per cent of the days (54 of 62 days). Summertime songs begin earlier (mean time = 0901 vs. 1004 h in winter) and are less clumped in their distribution than are winter songs (Fig. 2). Afternoon songs (range 1410-1600 h) were not given in the winter. In summer 75 per cent of gibbon songs occurred between 0800 h and 1100 h, and in winter all songs (100%) occurred during these hours. The later start and more restricted distribution of winter songs may be a function of the shorter daylight hours and colder temperatures that are associated with extensive sun basking before beginning the day's activity (see sunbathing).

Once a family group begins to sing, adjacent groups usually do not respond until the first group is finished. Thus, hoolock gibbon songs pass sequentially through the forest,

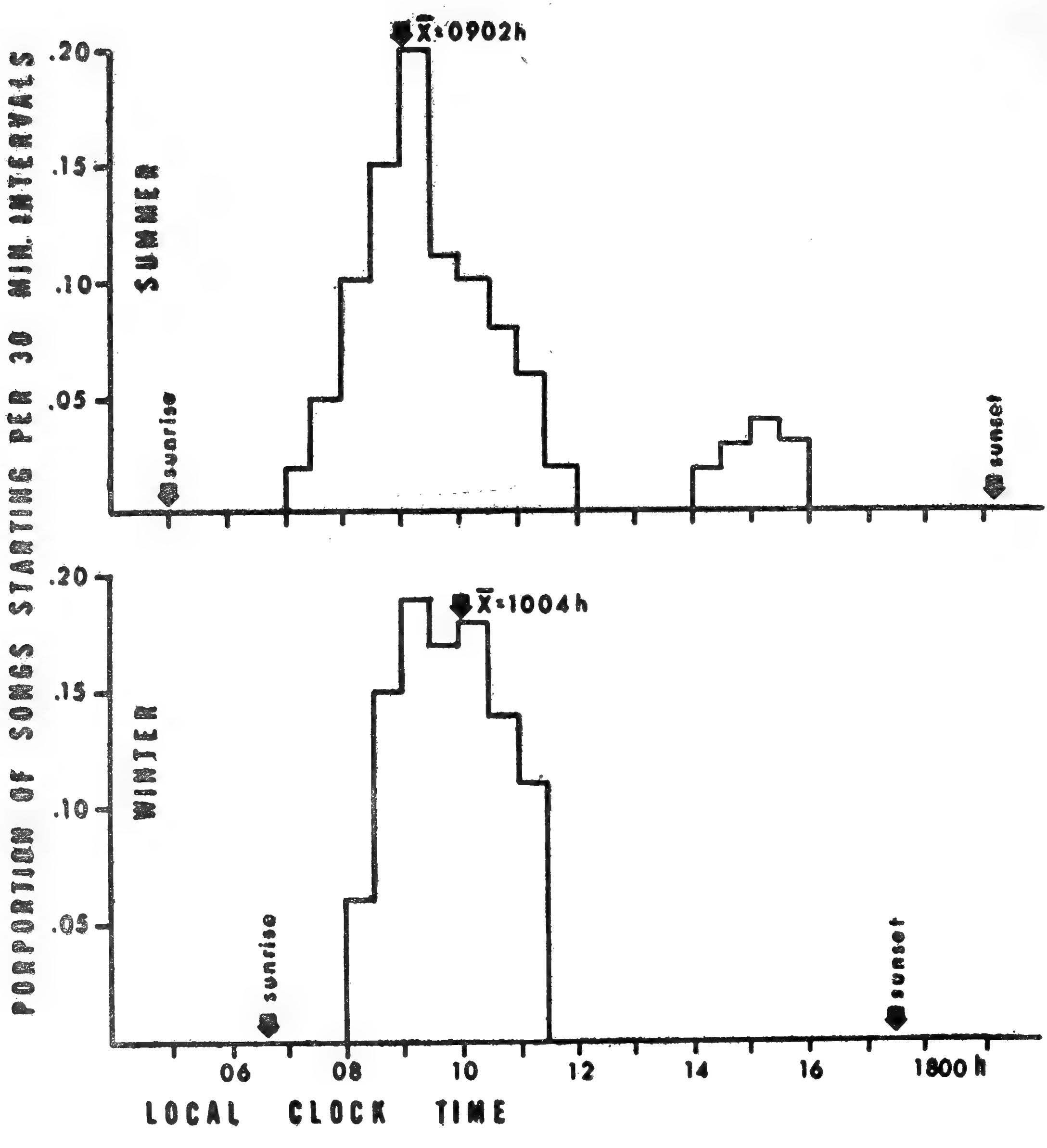


Fig. 2. Diurnal distribution of gibbon songs (per 30 min. interval) for summer and winter periods in Hollongapar Forest. Sunrise and sunset for these periods are indicated (from Ephemeris and Nautical Almanac, 1971-1972).

one group after another, much like the pattern of *H. syndactylus* songs (Chivers 1974) and in contrast to the multigroup choruses of *H. klossi* (Tenaza 1976). Although choruses do develop, 77 per cent of all recorded gibbon songs (n = 114) were delivered as solos. The mean interval between the end of one group's singing and the start of another group's song (discounting periods with more than 30 min lapse, n = 12) is 7.7 ± 7.8 min (range = 1-23 min). A single burst of song, lasting for 1-2 seconds, was heard eight times. These all occurred early in the morning 42 to 90 min before other groups began to sing.

Territory

Gibbons defend their space through loud morning songs, confrontations with intruders upon established boundaries and chasing tresspassers (Carpenter 1940, Ellefson 1974, Chivers 1974, Tenaza 1975). Singing advertises the occupation of a specific area of forest by a mated pair and functions as a distance-maintaining signal (Marler 1968). Although no intergroup encounters were observed, gibbons did sing on 87 per cent of all days. Each group sang from within the area circumscribed by its daily movements. These areas, with a mean size of 22 ha (range = 18-30 ha, n=7), overlap each other at the edges. Overlap zones vary from 50-75 m wide and amount to about 23 per cent of each family's space. They are considered to be territorial boundaries. Hoolock gibbon territories are comparable in size to those of other gibbon species (Table 3).

TABLE 3

HOOLOCK GIBBON TERRITORY SIZES COMPARED WITH OTHER GIBBON SPECIES

Species	Location	Territory Size (ha) Mean	Range	N	Source
H. hoolock	North Assam	22	18-30	7	Tilson, this study
H. lar	North Thailand	26	12-41	3	Carpenter, 1940
H. lar	East Malaya	39	20-47	4	Ellefson, 1974
H. syndactylus	Central Malaya	25	15-35	2	Chivers, 1974
H. klossii	Mentawai Islands, Indonesia	7	5-8	13	Tenaza, 1975
H. klossii	Mentawai Islands, Indonesia	12	7-13	15	Tilson, in prep.

Feeding Behaviour

A total of 43 species of food trees utilized by gibbons were identified. These trees represent 16 families and include 28 genera (Table 4). The food list is incomplete, but it does impart an impression of the proportions of various food items in the gibbon diet. Of these 43 species 53 per cent produce fruits eaten by gibbons. On the average, hoolock gibbons spend 67 per cent of their feeding time on fruit, 32 per cent on leaves and flowers and 1 per cent on insects. These data reflect the winter diet and may not be comparable to the summer diet. My impression, however, is that fruit may be consumed even more frequently during the summer months, but the data were too few for valid comparison.

Gibbon daily activity varied seasonally. In winter (November-February) feeding began 2.4 h after sunrise (mean = 0910 h). Once started, they fed continuously through the day, finishing near sundown (1710 h). Except for the subadult male, family members usually

TABLE 4

MAJOR FOOD TREES OF GIBBONS IN HOLLONGAPAR FOREST AND THEIR FRUITING SEASONS

Tree species	Bud-flower	Fruit	Leaf	Fruiting season
Anacardiaceae				
Mangifera indica	–	+	–	Aug.
Bombacaceae				
Bombax insigne	+	+	+	Aug.
B. malabaricum	+	+	+	Aug.-Sept.
Burseraceae				
Canarium bengalense	–	+	–	Oct.-Nov.
C. resiniferum	–	+	–	Oct.-Nov.
Dilleniaceae				
Dillenia indica	+	+	+	June
Dipterocarpaceae				
Dipterocarpus macrocarpus	–	+	+	Oct.-Nov.
Lagerstoemia flosreginae	+	–	+	Oct.-Nov.
L. parviflora	+	–	+	Oct.-Nov.
Shorea robusta	+	–	+	Oct.-Nov.
Terminalia bellirica	–	+	+	Nov.-Feb.
T. citrina	+	–	–	Nov.-Feb.
T. myriocarpa	+	–	–	Nov.-Feb.
Anthrocephalus cadamba	+	–	+	July-Aug.
Euphorbiaceae		+	–	July-Aug.
Bridelia retusa	–	+	–	Sept.
Endospermum chinense	–	+	–	Aug.-Sept.
Guttiferae				
Callophyllum polyanthum	–	+	–	July
Garicinia sp.	–	+	–	Jan.
Lauraceae				
Litsea citrata	+	–	+	Jan.
Phoebe cooperiana	+	–	+	Jan.
P. goalparansis	+	–	–	Jan.
Leguminosae				
Albizzia lebbek	+	–	–	Jan.
A. procera	+	–	+	Jan.
A. stipulata	+	–	+	Jan.
Parkia roxburghii	–	+	+	May-Aug.
Moraceae				
Artocarpus chaplasha	–			
A. integriflora	–	+	+	Aug.-Sept.
A. khasiana	–	–	+	Aug.Sept.
A. lakoocha	–	+	+	Aug.-Sept.
Ficus glomerata	+	+	+	Jan.-July
F. nervosa	+	+	–	Aug.-Oct.

Tree species	Bud-flower	Fruit	Leaf	Fruiting season
Myrtaceae				
Eugenia jambolana	–	+	–	Mar.-Sept.
Eugenia sp.	–	–	+	Mar.-Sept.
Sapotaceae				
Palaquium polyanthum	–	–	+	Mar.-Sept.
Sterculiaceae				
Hertiera acuminata	–	+	–	Jan.-Feb.
Mansonia dipikae	+	+	–	Nov.
Sterculia alata	–	+	–	July
S. campanulata	–	+	–	June-July
S. villosa	–	–	+	June-July
Theaceae				
Schima wallichii	–	+	–	Dec.
Ulmaceae				
Celtis australis	+	+	–	Sept.
Verbenaceae				
Premna bengalensis	–	+	+	Dec.
Vitex sp.	–	+	+	(Variable)

fed together in the same tree or group of trees. They moved between feeding trees along direct routes, and little or no feeding occurred in transit. Average feeding time for a 10-day period was 322 min (range = 260 to 445 min).

In contrast, summer feeding began earlier (3 h after sunrise, mean = 0810 h), and more time was spent resting and in social contact with the family unit. The longer summer days (14 h vs. 10 h) allowed more time for social activity, and the warmer mornings may preclude basking in the sun. The average feeding time for a 10-day period was not significantly different (mean = 295 min; range = 251 to 386 min.)

Reproduction

McCann (1933) observed that many of the adult females he encountered were carrying newly born infants and suggested that hoolock gibbons have a birth peak during the winter. In Hollongapar forest three of the seven mated adult females gave birth between mid-November and the end of January. During the same period four new infants were observed in nearby forests. These sites are within 50 km of where McCann made his observations. Young infants were not seen during other months, either in Hollongapar or elsewhere. These data, although few, support McCann's tentative conclusion that hoolock gibbons have a winter birth season.

Sunbathing

Gibbons in Hollongapar bask in the sun on cold winter mornings. In each territory there were 1-3 trees used for basking. These trees may be favoured by virtue of their central location within the territory, their greater height in relation to the surrounding canopy and their lack of leaves. The family usually moves into one shortly after sunrise. Individuals space out in the tree, sitting on the higher branches with their ventral surface oriented towards the sun.

As the chest is more sparsely coated than the rest of the body, this posture emphasizes the role of heat absorption while sunbathing (Hamilton 1973). The chest of adult females is darker than the rest of the body, and in older females it appears black. In the winter, when ambient temperatures in the morning (0800 h) are low (mean = 10.1°C), gibbons bask nearly every day. A group of three gibbons in Hollongapar sunbathed 11 of 12 days (92 per cent) for an average of 92 min (range = 40-135 min) per day in the winter. In summer, when temperatures are higher (mean = 27.4°C), this same group sunbathed on only 9 of 16 days (56 per cent) for an average of 26 min (range = 12-45 min) per day.

Discussion

All species of gibbons studied so far share the same features of social organization. Their social unit is a monogamous adult pair with up to four offspring spaced two to three years apart (Tenaza 1975). Family balance is maintained by excluding offspring as they become sexually mature (Carpenter 1940, Brockelman *et al.* 1973, Ellefson 1974, Chivers 1974). This process has been reported only for males. Subadult males of *H. lar, H. syndactylus* and *H. klossi* are excluded through threats and aggression from the adult male (Ellefson 1974, Aldrich-Blake and Chivers 1974) as are *H. hoolock* males. The solitary subadult female in Hollongapar suggests females also are excluded from the group and territory. These observations on *H. hoolock* support in part the hypothesis that intrasexual aggression may be the proximal basis of monogamy in all gibbons (Tenaza 1975).

The defense of mutually exclusive territories is known for three species of gibbons (*H. lar,* Ellefson 1968; *H. syndactylus,* Chivers 1974; *H. klossi,* Tenaza 1975). Space is defended by loud morning songs and more rarely by aggressive intergroup encounters upon boundaries (Ellefson 1968, Chivers 1974) and intrasexual chasing of trespassers (Tenaza 1975). Although no intergroup encounters between adjacent families were observed in *H. hoolock,* their daily songs and exclusive feeding areas imply that they are territorial. The 22 ha territories reported here for *H. hoolock* are 32 per cent larger than those of *H. klossi* (Tenaza 1975) and from 12 to 44 per cent smaller than those of *H. lar* (Carpenter 1940, Ellefson 1968) and *H. syndactylus* (Chivers 1974). These variations in size have little comparative value until the relevant measurements of food resource availability are made in the various forests. Monogamy and territoriality, however, are common to all gibbon species, even though they have been reproductively isolated for at least 10-15,000 years.

Gibbons are exclusively arboreal except for rare visits to the ground to retrieve dropped food (Ellefson 1974), to cross short distances devoid of forests (Ellefson 1974), or to have combat (Tenaza 1975). Their suspensory locomotion adapts them to exploit the terminal branch niche (Ellefson 1974, Grand 1972), where they feed on a variety of new leaves, flowers, and especially fruit. *H. lar* in Thailand and Malaya spend from 70 to 80 per cent of their feeding time consuming fruit (Carpenter 1940, Ellefson 1974), *H. hoolock* 67 per cent, and *H. syndactylus* 30 to 40 per cent (Chivers 1974). Regardless of these different percentages of fruit in the diets of different gibbon species, fruit makes up the major part of all gibbon diets with the exception of the siamang.

Gibbon sexual activity is thought to be stimulated by irregular surges in fruiting seasons (Chivers 1974, Tenaza 1975). Field observations on primates other than gibbons support

Fig. 3. An adult male *H. hoolock*. Note the conspicuous white eyebrows, which are joined in hoolock gibbons west of the Chindwin River, Burma, but well separated in those east of the river (Groves 1967).

this view. In the Indian subcontinent rhesus macaques (*Macaca mulatta*) have a distinct breeding season (Southwick *et al.* 1965), while bonnet macaques (*M. radiata*) (Rahman & Parthasarathy 1969), grey langurs (*Presbytis entellus*) (Sugiyama & Parthasarathy 1969), Nilgiri langurs (*P. johnii*) (Poirier 1968, 1970) and Purple-face langurs (*P. senex*) (Rudran 1973) show peaks in sexual activity, although mating occurs throughout the year. These species all have a birth peak in the dry season. Rudran (1973) correlated increased sexual activity and early gestation in *P. senex* with high rainfall, increased food and decreasing temperature. Rudran (1973) and Rahaman (1973) suggest such periodicity is to synchronize infant weaning with the monsoon, when new leaves, buds and flowers are more abundant. Observations on *H. hoolock* infant births here and by McCann (1933) show a birth peak in the dry season as well. With a seven-month gestation period (Badham 1967, Hill 1967) most mating would occur during the monsoon. This direct reproductive response to favourable food resource conditions has been reported for Malaysian primates as well (Medway 1972).

Fooden (1969) first identified the geographical pattern of the distribution of colour-phase variation in gibbons. Monomorphic species, in which individuals of both sexes are the same colour, are restricted to the southern or Indo-Malayan range. Sexually dimorphic species, in which adult males are dark and adult females are light (*H. hoolock, H. pileatus, H. concolor*) are restricted to the northern or Indochinese range. The intermediate asexually dichromic species straddle the zone between these two regions. Fooden (1969) suggests that the dichromatism of *H. hoolock* evolved from primitive monomorphism (with asexual dimorphism as an intermediate step) during the radiation of gibbons into the northern latitudes. The adaptive significance of this dichromatism, however, is obscure.

The colour change of *H. hoolock* was established by McCann (1933). At birth the infant is nearly white. As the infant ages the coat darkens until it is completely black; only the conspicuous eyebrows remain white (Fig. 3). Both sexes pass through this colour change. In males the dark colouring deepens with age to a glossy black, while a second colour change occurs for females at about 6-8 years of age. Her black coat gradually fades to buff colour as she attains sexual maturity. With age the chest of many females darkens until it appears black. The all black coat of adult males and immature offspring of *H. hoolock* may enhance heat absorption and allow for reduced basking time. The lighter coat of the female may be counterselected for by being more cryptic and thus less conspicuous to predators. The black chests of females in the other two sexually dichromic gibbons (*H. pileatus* and *H. concolor*), both of which are northern species, and the greater frequency of black morphs (69 per cent; 64 of 93 specimens) in the asexually dichromic gibbon *H. lar* in northern Thailand (Fooden 1969) suggests that blackness may confer a thermal advantage and thus could have been selected for during the adaptive radiation of gibbons into the northern latitudes.

Acknowledgements

This study was supported through funds from the Smithsonian Institution. I am indebted to Shri P. Barua, Chief Conservator of Forests, Assam; Dr. K .N. Sharma, Department of Zoology, Gauhati; Dr. B. Biswas, Indian Museum, Calcutta and the many District Forest Officers I interviewed for their cooperation during my

surveys of Assam and for their useful information on gibbons in their areas. I am grateful for the invaluable assistance of W. Mills in New Delhi and for the hospitality of the Greystone family, Kotalgoorie T. E., in Assam. Special thanks go to Wazir Khan, Moabund T. E., for showing me my first wild hoolock gibbons.

I am especially indebted to W. J. Hamilton, III, and R. R. Tenaza for introducing me to gibbons and for suggesting that I go to Assam. Their comments on this paper and those of C. Busse and D. Lindburg are appreciated.

References

Aldrich-Blake, F. P. G. and Chivers, D. J. (1973): On the genesis of a siamang group. *Amer. J. phys. Anthrop. 38*:631-636.

Anderson, J. (1978): Anatomical and zoological researches: zoological results of the two expeditions to western Yunnan in 1868 and 1875. Vol. I. London. Bernard Quaritch.

Andrews, R. C. and Andrews, Y. B. (1918): Camps and trails in China. New York. Appleton.

Anonymous (1972): Gibbons in Mahananda Wildlife Sanctuary. *Cheetal 1*:96.

Badham, M. A. (1967): A note on breeding the pileated gibbon. *Int. Zoo Yb.* 7:92-93.

Brockelman, W. Y. Ross, B. A., and Pantuwatna, S. (1973): Social correlates of reproductive success in the gibbon colony on Ko Klet Kaeo, Thailand. *Amer. J. phys. Anthrop. 38*:637-640.

Brown, J. L. (1969): Territorial behaviour and population regulation in birds. *Wilson Bull. 81*:293-329.

Candler, G. (1904): Notes on the habits of the Hoolock. *J. Bombay nat. Hist. Soc.* 15:700-703.

Carpenter, C. R. (1940): A field study in Siam of the behaviour and social relations of the gibbon (*Hylobates lar*). *Comp. Psychol. Monogr. 16*:1-212.

Carter, T. D. (1943): The mammals of the Vernay-Hopwood Chindwin expedition, northern Burma. *Bull. Amer. Mus. nat. Hist. 82*:99-120.

Champion, H. G. (1936): A preliminary survey of the forest types of India and Burma. *Indian For. Rec.* (N.S.) 1(1):1-286.

——— and Griffith, A. L. (1948): Manual of Silviculture for India. Oxford.

Chivers, D. (1974): The siamang in Malaya: A field study of a primate in a tropical rain forest. *Contrib. primatol. 4*:1-335. Basel. S. Karger.

Das, H. P. (1970): Geography of Assam. New Delhi. National Book Trust.

Ellefson, J. O. (1968): Territorial behaviour in the common white-handed gibbon, *Hylobates lar* Linn. *In* Primates: Studies in Adaptation and Variability: 180-199. Jay, P. (ed.) New York. Holt, Rinehart and Winston.

——— (1974): A natural history of White-handed gibbons in the Malayan Peninsula. *In* The Gibbon and the Siamang. Vol. 3. Rumbaug, D. (ed) Basel. S. Karger.

Fooden, J. (1969): Color-phase in gibbons. *Evolution* 23:627-644.

Grand, T. I. (1972): A mechanical interpretation of terminal branch feeding. *J. Mammal. 53*:198-201.

Groves, C. P. (1967): Geographic variation in the Hoolock or White-browed gibbon (*Hylobates hoolock* Harlan 1834). *Folia primatol. 7*:276-283.

——— (1972): Systematics and phylogeny of gibbons. *In* The Gibbon and the Siamang. Vol. 1. Rumbaug, D. (ed) Basel. S. Karger.

Hamilton, W. J., III (1973): Life's Color Code. New York. McGraw-Hill.

Hill, C. A. (1967): A note on the gestation period of the siamang. *Int. Zoo Yb.* 7:93-94.

Marler, P. (1968): Aggregation and dispersal, two functions in primate communication. *In* Primates: Studies in Adaptation and Variability. Jay, P. (ed) New York. Holt, Rinehart and Winston.

Marshall, J. T., Ross, B. A. and Chantharojvong, S. (1973): The species of gibbons in Thailand. *J. Mammal. 53*:479-486.

——— and Marshall, E. R. (1976): Gibbons and their territorial songs. *Science 193*:235-237.

McCann, C. (1933): Notes on the colouration and habits of the White-browed gibbon or Hoolock (*Hylobates hoolock* Harl.). *J. Bombay nat. Hist. Soc. 36*:395-405.

McClure, H. E. (1966): Flowering, fruiting and animals in the canopy of a tropical rain forest. *Malayan Forester. 29*:182-203.

Medway, Lord (1972): Phenology of a tropical

rain forest in Malaya. *Biol. J. Linn. Soc. 4*:117-146.

MOUNTFORT, G. (1969): The Vanishing Jungle. London. Collins.

PARSONS, R. E. (1940): Rivers as barriers to the distribution of gibbons. *J. Bombay nat. Hist. Soc. 42*(2):434.

——— (1941): Rivers as barriers to the distribution of gibbons. *J. Bombay nat. Hist. Soc. 42*(3):926.

POCOCK, R. I. (1941): The fauna of British India, including Caylon and Burma. Mammalia, Vol. II. London. Taylor and Francis.

POIRIER, F. E. (1968): The Nilgiri langur (*Presbytis johnii*) mother-infant dyad. *Primates 9*:45-68.

——— (1970): The Nilgiri langur (*Presbytis johnii*) of South India. *In* Primate Behaviour: Developments in Field and Laboratory Research: 251-383. Rosenblum, L. A. (ed) Vol. I. New York. Academic Press.

RAHAMAN, H. (1973): The langurs of the Gir Sanctuary (Gujarat)—a preliminary survey. *J. Bombay nat. Hist. Soc. 70*:295-314.

——— AND PARTHASARATHY, M. D. (1969): Studies on the social behaviour of bonnet monkeys. *Primates 10*:149-162.

RICHARDS, P. W. (1966): The Tropical Rain Forest: An Ecological Study. London. Cambridge University Press.

RODMAN, P. (*in press*): Diets, densities and distributions of Bornean primates. *In* Arboreal Folivores. Montgomery, G. G. (ed).

RUDRAN, R. (1973): The reproductive cycles of two sub-species of purple-faced langurs (*Presbytis senex*) with relation to environmental factors. *Folia primatol. 19*:45-68.

SOUTHWICK, C. H., BEG, M. A. AND SIDDIQI, M. R. (1965): Rhesus macaques in North India. *In* Primate Behavior: 111-159. De Vore, I. (ed) New York. Holt, Rinehart and Winston.

SUGIYAMA, Y. AND PARTHASARATHY, M. D. (1969): A brief account of the life of Hanuman langurs. *Proc., Nat. Inst. Scie. Ind. 35*:306-319.

TENAZA, R. R. (1975): Territory and monogamy among Kloss' gibbons (*Hylobates klossii*) in Siberut Island, Indonesia. *Folia primatol. 24*:60-80.

——— (1976): Songs, choruses and countersinging of Kloss' gibbons (*Hylobates klossii*) in Siberut Island, Indonesia. *Z.Tierpsychol. 40*:37-52.

A BOTANICAL SURVEY OF *CANNABIS* IN THE HIMALAYAS[1]

G. K. Sharma[2]

The Himalayas are known for their wild or nearly wild populations of *Cannabis*. These mountain ranges also have a folklore for *Cannabis*. Botanical studies of *Cannabis* populations in their natural habitats in the Himalayas are of great significance for understanding the ecological, biochemical, and genetic relationships existing in the taxon. It is suggested that a concerted, thorough investigation of this mysterious plant be made in its probable home in the Himalayas. The findings of a preliminary survey of *Cannabis* in the Himalayas are discussed.

The purpose of this paper is to report some botanical characteristics and phenotypic variations in *Cannabis* as observed in a wide variety of microhabitats and macrohabitats in the northern Himalayas.

The Himalayas are an excellent laboratory for the study of *Cannabis*. This enigmatic taxon occurs in the 2,500 kilometre long Himalayan arc stretching from Afghanistan to Burma and covering the northern highlands of Afghanistan, Pakistan, India, Tibet, Nepal, Bhutan, and Burma. *Cannabis* is considered native to central Asia. The northern Himalayas have wild or nearly wild populations, mostly untouched by man. These mountains have large areas of sparse human habitation, permitting the discovery of pockets of wild populations in the area. In addition, some of the ancient scriptures of India mention the medical, religious, and social significance of *Cannabis* in the area as far back as 5,000 B.C. The sacred *Vedas* and *Susrita* are scriptures known for their descriptions of this plant, one of man's oldest companions in the northern Himalayas.

Cannabis is five-purpose economic plant: the source of fiber, food, medicine, oil, and narcotic. Accordingly, it is commonly cultivated in the Himalayas. It is an extremely misunderstood plant, especially in the western countries of the world. There is no agreement concerning its family assignment. There is controversy about its taxonomy. It has been maintained by some (Small 1974; Small and Cronquist 1976) that there is only one species, *Cannabis sativa;* while others (Emboden 1974; Schultes *et al.* 1974) believe it to be polytypic. Ecologically, it presents several baffling problems. Its plasticity is not completely understood. The factors controlling its weedy aggressiveness and its narcotic potency are still argued by many. These biological enigmas have social and legal implications, especially in Western countries where it is widely used or misused as an inebriant.

Strangely there is dearth of biological data on *Cannabis* in its natural habitat in the northern Himalayas. Preliminary information on altitudinal variation and embryology is, however, available (Ram and Nath 1964; Sharma 1975). I travelled extensively in the northern Himalayas in 1970, 1973, and 1976 making

[1] Accepted May 1978.

[2] Professor of Botany, University of Tennessee at Martin & Research Fellow, Botanical Museum, Harvard University, U.S.A.

field observations and collecting data on *Cannabis* from a wide variety of habitats and elevations in areas conspicuous for their populations of *Cannabis*. Most of the observations were made in the provinces of Himachal Pradesh, Punjab, and Jammu & Kashmir in northern India. These areas of northern India are contiguous to the wild, uninhabited borders of Tibet and Pakistan. Gross morphological variations in populations and general features of their habitat were recorded in the field.

During laboratory studies on *Cannabis* of different geographic origins from different countries of the world, there is a tendency to label the habitat of these populations corresponding to the general climatic conditions of that country without any real consideration of the fact that local microhabitat parameters are extremely crucial to the growth and phenotype of *Cannabis*. It is, moreover, doubtful if the laboratory or controlled studies without the basic supplemental data from the native range and habitat of *Cannabis* can aid in clarifying many of the botanical, ecological, and biochemical problems. Our knowledge gap is often the direct result of lack of study of *Cannabis* in its natural habitat. Thus, different microhabitats representing extremely diverse conditions within a country can lead to extensive plasticity and variability in *Cannabis*. This phenomenon is true especially in the Himalayas, where *Cannabis* exhibits especially high plasticity. Unless it be studied in depth in its probable home—the Himalayas, it is doubtful whether we can resolve many of our uncertainties about the plant.

It is not unusual to find two different populations of *Cannabis* exhibiting entirely different morphological features on the same slope. It owes this remarkable plasticity to ecological factors in the microhabitat. It is erroneous, for example, to say that *Cannabis* from a certain slope represents a certain population, since I have seen the difference of a single factor producing variation in plant populations on the same slope.

In the areas surveyed between 250 and 3,050 metres, I found distinct variation in the gross morphology of *Cannabis* populations. Plant habit, size, leaf size and colour, foliar characteristics (colour, growth, and odour) and seed size were found to be plastic—a plasticity depending upon habitat, elevation, and soil factors. Plants growing on man-made, nutrient-rich soils grew to a height of more than four metres with dark green, strong-smelling foliage—and this regardless of elevation. These plant populations produced large leaves, thick stems, and extensive roots. Furthermore, these plants cannot be called truly wild: they were either grown by man or indirectly nourished by man. *Cannabis* growing in the same general area but not on refuse or man-altered, nutrient-rich soil exhibited growth typical of the ecological region.

Under wild conditions, however, *Cannabis* at higher elevations was larger, laxly branched, vigorous, and had larger leaves than at lower elevations. They also had a strong odour and bright green foliage.

Cannabis is a heliophile: quite evident in its probable native home in the higher elevations in the Himalayas. Of all the populations surveyed in these mountains, I found not even a single population growing in the shade. In the plains area or at low elevations, where summer temperatures were extremely high (40°C), *Cannabis* grew both in shade and in direct sunlight.

At higher elevations, nearly all the *Cannabis* grew on south-facing slopes exclusively while the north-facing slopes-cooler and moister-were devoid of *Cannabis*. At lower eleva-

tions, however, both the north-facing and south-facing slopes had populations, because of the favourable temperatures, an important feature affecting the botany and ecology of the plant during its entire life cycle. I found no *Cannabis* populations above 3,050 metres in the northern Himalayas.

In all cases, pistillate *Cannabis* was found to be more branched and bushy than the weaker-looking staminate individuals. This distinction was one of the best ways to separate male from female prior to flowering. Further, pistillate plants were generally bright green, while staminate individuals were greyish green. The "bark" of the older females was somewhat thicker than that of the males. A close look at the lower section of the stems of female plants showed distinct, horizontal ridges, whereas the male stems had dots or tiny spot-like structures, less conspicuous than the ridges of the female. This pattern I observed consistently in all habitats at all elevations.

Cannabis is usually the dominant plant in an herbaceous plant community—thus supporting the suggestion that its aggressiveness or dominance may be due to allelopathic properties. Very few weeds were able to grow among or compete with *Cannabis,* especially at lower elevations, where pure colonies of the plant were abundant. In cultivated fields, therefore, *Cannabis* is considered to be a menace to other crops and is weeded out as early as possible.

Generally, at high elevations, the seeds from the preceding autumn germinate about the end of March. Blooming occurs in early June, and the enormous amount of pollen produced by male plants becomes extremely conspicuous in the atmosphere. In the plains at lower elevations, pollen production occurs even earlier in the growing season, since the seeds produced in early autumn germinate in December or January, leading to earlier blooming. At high elevations, *Cannabis* produces seeds in late summer, while ripening takes place in November, the plant then dies. Cold winters at high elevations provide a dormant period; hence germination of seeds produced in the preceding season does not take place until March of the following year.

While it is known that *Cannabis* has had a long association with man, there are many disturbed habitats in the area where *Cannabis* has carried on well for years without any direct interference by man. Abandoned terraces, old farm sites, roadsides, and railroads are some of the sites where *Cannabis* colonized as a dominant species. Cultivated fields are also invaded by *Cannabis,* although it is weeded out early in the growing season simply for survival of the cultivated crops. When it competes and survives in both wild and man-made habitats it exhibits its gregariousness—itself an enigmatic phenomenon, requiring detailed investigations.

A general count of male and female plants at low and high elevations indicated a gradual preponderance of female individuals over the male with increase in elevation. It might be interpreted as ensuring fertilization, seed production, and hence survival and continuity of the species in the relatively harsh environment and short growing season of higher elevations. The reverse was evident in the plains and at lower elevations, where male individuals outnumbered female plants. In all cases, male plants withered away earlier in the season than the female *Cannabis* plants.

Field observations in the Himalayas indicate clearly that sandy soils are decidedly poor for growth of *Cannabis,* whether in the plains, low elevations or at high altitudes. The plants growing in sandy soils were dwarfed or even prostrate in some cases with thin stems, small

leaves, small seeds, and gave the general appearance of stunted growth. Soils rich in organic matter, however, are the best for its growth. This observation in wild populations in the Himalayas supports the well recognized fact that *Cannabis* is a "heavy feeder."

Plants in the plains area were usually smaller than plants under similar habitats at higher elevations. Seeds produced by populations at high elevations were larger than those at low elevations. But, the plants of lower elevations produced seeds in greater abundance—perhaps a significant evolutionary characteristic. It seems, therefore, safe to suggest that in the northern Himalayan region, seed size in *Cannabis* is proportional to plant size and to overall vigour of growth. Furthermore, I found a slight colour difference in seeds of different populations. Seeds of mountain populations tended to be somewhat light grey, while the colour in the plains was distinctly dark grey.

I must make special mention of several populations growing in valleys (elevation 2,500 metres+) surrounded by ice and snow-covered mountains in the background rising to a height of 7,000 metres. Cool, dry, crisp mountain breezes were typical of these areas. Sunny, clear, bright days characterized the early autumn, and the nights were bitterly cold. These are areas renowned for extremely potent *Cannabis*. The plants collected from these areas had a very rank-smelling, dark green foliage, excellent growth, and large seeds —suggestive that these characteristics might possibly be correlated with the narcotic strength of the plants.

Finally, it seems obvious that *Cannabis* shows great phenotypic plasticity and perhaps corresponding variation in narcotic potency in different habitats in the northern Himalayas, although the latter speculation requires long and critical biochemical analysis. Intensive and extensive botanizing in the Himalayas will undoubtedly produce answers to many of the questions posed by this bewildering plant. The legal, bureaucratic, and social implications at present certainly hinder free flow of information and understanding of *Cannabis* in its natural habitat in the Himalayas. *Cannabis* research does not have the same glamour in the East as it does in western countries for very obvious reasons. It is doubtful, therefore, that scientific skills and/or resources of the East can be expected to be applied to a thorough botanical and ecological investigation. As a result, a major hurdle to understanding this important plant in its natural habitat in central Asia needs to be cleared.

References

Emboden, W. A. (1974): *Cannabis*—a polytypic genus. *Economic Botany 28*: 304-310.

Ram, H. Y. Mohan and Nath, R. (1964): The morphology and embryology of *Cannabis sativa* L. *Phytomorphology 14*: 414-429.

Schultes, R., Klein, W., Plowman, T., and Lockwood, T. (1974): *Cannabis*: an example of taxonomic neglect. *Harvard Univ. Bot. Mus. Leafl. 23*: 337-367.

Sharma, G. K. (1975): Altitudinal variation in leaf epidermal patterns of *Cannabis sativa*. *Bull. Torrey Botanical Club 102*: 199-200.

Small, E. (1975): On toadstool soup and legal species of marihuana. *Plant Science Bulletin 21*: 35-39.

Small, E. and Cronquist, A. (1976): A practical and natural taxonomy for *Cannabis*. *Taxon 25*: 405-435.

A COMMENT ON *ACTINODURA NIPALENSIS* (AND *WALDENI*)[1]

S. Dillon Ripley[2]

In the Journal of the Bombay Natural History Society (1961:281), I commented on some birds from northern Burma and concluded, as Rothschild had suggested (1926), that two species in this genus, *nipalensis* and *waldeni* should be kept separate. Consequently in my SYNOPSIS (1961), and in the HANDBOOK (S. Ali and Ripley 1972, 7, p. 86-89) we have maintained the forms as two separate species.

A brief visit to Arunachal Pradesh in January-February, 1978, has given me the opportunity of examining freshly collected *Actinodura* which on field observation I assumed to be *A. nipalensis*. We found the species at Bomdila, Kameng District at an altitude of 8400 feet. On comparing these specimens with recently collected *Actinodura nipalensis* from Bhutan and Nepal in the National Museum of Natural History, as well as old skins in the American Museum of Natural History from Sikkim I immediately saw that I was in error in my past arrangement.

Ticehurst (1935, p. 57) agreed with Baker in the "FAUNA" (1922, p. 307-309) that these populations of *Actinodura* should be kept in one species, thus disagreeing with Rothschild. That Ticehurst's opinion, and Baker's was correct I now believe. I should have been alerted by the obvious fact of forty years ago that agreement among these late authors was uncommon enough to lend extra weight to a jointly-held opinion.

[1] Accepted May 1978.

[2] Smithsonian Institution, Washington, D.C. 20560, U.S.A.

The problem is partly explained by the degree of "foxing" or change of tone of old specimens in museum collections. When I compared freshly-collected *Actinodura nipalensis* from Bomdila with an ancient skin of *Actinodura waldeni daflaensis* from the Miri Hills (=Lakhimpur District immediately to the east), I could not at first recognize that the fresh specimens could possibly represent *daflaensis,* and not an undescribed race of *nipalensis,* so startling were the apparent differences in colour tone.

Daflaensis is listed by Sálim Ali and myself (tom. cit.) as a subspecies of *waldeni,* as I had placed it in SYNOPSIS. The older skins in collections have the rufous coloration, and streaking, especially below, associated with *waldeni.* However, the fresh skins collected by myself at Bomdila are markedly different from *A. nipalensis* to the west. The only solution is that they represent *daflaensis.* How then is *daflaensis,* originally described by Godwin-Austen (1875) to be characterized? Here are the salient points of the original description;

"As might be expected, its (*daflaensis*) nearest ally is *A. nipalensis,* Hodgs., the coloration above being very similar on the back and tail, but with less rufous barring. The crest, however, is quite different; and in this respect the species approaches *A. waldeni* from the Naga Hills, on the south of the Brahmaputra valley, only that the crest is far fuller. The general blotchy streakiness of the throat and breast is also a mark of connection with *A. waldeni*......head, ash-brown; fea-

thers in front spatulate, behind elongated into a full crest, narrowly pale-edged......side of head ash-grey, the ear-coverts with light silky reflections......Beneath—the chin and throat pale dingy white, becoming a dirty ochry ash on the breast, with a blurry striation particularly on the throat."

In Baker (tom. cit.) the description of *daflaensis* differs in comparing the form to *waldeni* by stating; "Similar to *"I."* (=*Ixops*) *n. waldeni* but a darker, duller chestnut above and the chin, throat and breast feathers grey with reddish-brown central streaks, the whole effect being grey, not rufous; ear coverts a rather darker grey."

On examination of these specimens I feel that I was mistaken as well in naming a new subspecies *Actinodura nipalensis vinctura*. The original description (1950), stressed the "deeper black band on the terminal upper surface of the tail, and noticeably heavier black barring on wings and tail." While there is a continuous geographical clinal difference from west to east in the tendency towards a darker, more blackish tip to the tail and heavier barring on wings and tail, I find that there is a great deal of variation in the streaking on head and back, width of bars on wings and tail, colour of ear coverts and tendency to faint streaking on the throat and upper breast. Thus the variable appearance of this population which extends from central Nepal to east Bhutan is better left as *nipalensis nipalensis* with *n. vinctura* as a synonym.

For the record then I propose to list the characteristic appearance of *Actinodura nipalensis daflaensis* as follows;

freshly collected *daflaensis*—

differs from *nipalensis* in the darker, more uniform, dark grayish brown cap, (of Smithe's Color Guide, New York, 1975) extending from the bill over the crown, the softly rounded crest projecting over the nape. The paler, buff shaft streaks are reduced to hair-line size on the crown feathers. There are also hair-width edgings of dull buff to these crown feathers, lacking in *nipalensis*. The back is unstreaked, dark "burnt umber" (of Smithe), or dark rufous olive-brown, somewhat variable in tone in individuals. The wings and basal half of the tail are heavily barred with broad black bars, the terminal half of the tail uniform black with dull whitish tips on the central tail feathers. The cheeks and ear coverts are olive gray with a glaucus tone, giving a light sheen to the feathers, darker than the somewhat clay-coloured glaucus olive gray in *nipalensis*. Compared to *nipalensis* the moustachial streak from the base of the bill running back to the side of the neck and separating the paler throat colour, is more indistinct, reduced in its sharp demarcation between head and throat.

Below, *daflaensis* has a light neutral gray throat with pale, olive-gray streaks on the centers of the feathers. The breast is darker, a light neutral-gray (Smithe) with poorly defined olive-gray or glaucus central streaks, somewhat blurred in definition, not sharply defined. The lower belly and flanks are similar to *nipalensis*, shading into tawny olive-brown. In *nipalensis*, the throat is much darker, smoky-gray with only an indication of streaking, the breast is unstreaked and infused with a tint of olive-brown in the dirty grayish tone.

In old skins, *daflaensis* appears darker more uniform on the crest, lacking the central shaft streaks of *nipalensis*, more rusty-brown on the back, also unstreaked, and below definitely streaked on a lighter throat which is smoky-gray rather than light gray. The breast has darkened with age in old skins, darker and dirty olive-gray in tone. The streaking distinguishes such specimens from the relatively

clear coloured, dark dirty smoke-gray of *nipalensis*.

In *waldeni* the crest feathers are more pointed, with distinct pale brownish-gray edges and dark brownish-black, sometimes blackish-brown centers. The back is uniform unstreaked, dark olive-brown. The cheek feathers are edged with silvery gray. The moustachial streak is reduced, the black feathers well edged with smoke gray, so as to lose their definition as a moustachial streak. The throat is straw brown, with hairline brownish central streaks, shading into cinnamon on the breast edged with light straw-brown. The cinnamon deepens slightly on the lower breast and belly due partly to the reduction and eventual disappearance of paler edging.

East and south of this range are two darker, more maroon or dark-maroon backed subspecies with darker throats and streaked breasts, *poliotis* of the Chin Hills, and *saturatior* of extreme north Burma and adjacent Yunnan with *wardi* as a synonym.

References

ALI, S. AND RIPLEY, S. DILLON (1972): Handbook of the Birds of India and Pakistan, vol. 6. Bombay: Oxford University Press.

BAKER, E. C. STUART (1922): The Fauna of British India, vol. 1. London: Taylor and Francis.

GODWIN-AUSTEN, H. H. (1875): Description of a supposed new *Actinura* from the Dafla Hills. *Ann. Mag. Nat. Hist. 16*: 339-340.

RIPLEY, S. D. (1950): New Birds from Nepal and the Indian Region. *Proc. Biol. Soc.* Washington, *63*: 101-108.

——————— (1961): Some Bird Records from Northern Burma with a Description of a New Subspecies. *J. Bombay nat. Hist. Soc. 58*(1): 279-283.

ROTHSCHILD, LORD (1926): On the Avifauna of Yunnan, with critical notes. *Novit. Zool., 33*: 274.

SMITHE, F. B. (1975): Naturalists' Color Guide. New York: American Museum of Natural History.

STANFORD, J. K. AND TICEHURST, C. B. (1935): Notes on some new or rarely recorded Burmese birds *Ibis*. Part. 1 : 46, 57; Part 2 : 271.

TYPE MATERIAL IN THE HERBARIUM OF THE BOTANICAL SURVEY OF INDIA AT POONA[1]

N. P. Singh and U. R. Deshpande[2]

It is clearly specified in the latest International Code of Botanical Nomenclature (Stafleu, 1972) that all taxonomic groups of the rank of family and below must be based on nomenclatural types. A nomenclatural type is that constituent element of a taxon to which the name of the taxon is permanently attached, whether as a correct name or as a synonym. It is necessary to indicate the nomenclatural type on the basis of which a taxon is created with effect from first January, 1958, according to the code.

The herbarium of the Botanical Survey of India, Western Circle, Poona (*BSI*) includes nearly 100,000 specimens collected since the reorganisation of the Circle in 1956 besides the historical collections of Cooke (over 30,000) and Talbot (over 10,000). A new genus, 30 species and a variety have been described from this Circle after its reorganisation. The types of these taxa are deposited in the regional herbarium. However, the holotypes of the above taxa are deposited in the *CAL*. Some types have also been deposited here by a few workers from outside the department. In addition, there are a good number of type specimens in the Cooke's & Talbot's collections. Therefore, it was thought desirable to prepare a consolidated list of such material present in the regional herbarium for the benefit of taxonomists, who may wish to refer such taxa for monographic as well as floristic studies.

A total number of 465 type sheets are deposited in the herbarium which includes 63 & 80 sheets in Cooke's & Talbot's collections respectively, besides 5 type photos. These represent 91 species and 4 varieties belonging to 66 genera and 32 families, which include 17 taxa in Cooke's and 35 in Talbot's collections. On a scrutiny of distribution of these taxa it is seen that as much as 37 belong to Maharashtra & 41 to Karnataka, of which 22 are from Poona (mostly recent collections) and 33 from North Kanara (mostly in Talbot's collections) respectively. Of the remaining 13 taxa, 5 are from Goa, 3 from Tamil Nadu, 2 from Kerala and 1 each from Rajasthan, Andhra Pradesh & Gujarat. Poaceae (27) has the maximum number of types followed, by Asclepiadaceae (8) & Rubiaceae (6). The genera *Ceropegia* & *Manisuris* have 6 species each. A total of 19 holotypes (in Cooke's & Talbot's collections), 51 isotypes, 15 syntypes (mostly in Cooke's & Talbot's collections), 96 paratypes (mostly in recent collections) & 2 neotypes are present in the herbarium besides 5 type photos and 4 type sheets which cannot be categorised due to lack of authentic information about the same. Many of the sheets have been categorised on the basis of corraborative evidence including Talbot's manuscript notes & protologue containing the illustrations etc.

In the following enumeration the families are arranged in Bentham & Hooker's system of classification. The genera, species & varieties

[1] Accepted May 1978.

[2] Botanical Survey of India, Western Circle, Poona.

are arranged in alphabetical order under each family. The original citation of each taxon along with name change, if any, is provided for easy location for reference. Under each taxon is given nature of type sheet with number within parentheses followed by locality, including the actual locality, district & State to which it belongs and Collector's name and number. The specimens belonging to Cooke's (C) & Talbot's (T) collections are indicated at the end in parenthesis. Doubts, if any, are indicated under each taxon individually.

RANUNCULACEAE

Clematis hedysarifolia DC. Syst. 1:148, 1817.

Type photo (1): Dasgown, in rupibus (Maharashtra), *A. P. Hove.* Herb. Musei Britannici.

CLUSIACEAE

Garcinia talbotii Raiz. ex Sant. Fl. Khandala (ed. 2) 14, 1960.

G. malabarica Talb. in J. Bombay nat. Hist. Soc. XI (2): 234, 1897 & (5): t. I, 1898.

Holotype (1) & *isotype* (1): Garsoppa ghat, North Kanara (Karnataka), *Talbot* 3713 (T).

MALVACEAE

Abutilon ranadei Woodrow et Stapf in Kew Bull. 87: 99, 1894.

Type (1)(?): Ambaghat, Ratnagiri (Maharashtra), without collector's name & number. (C).

No number is given in the protologue but since the specimen cited is from the type locality, it may be considered a type sheet.

BALSAMINACEAE

Impatiens talbotii Hook. f. in Rec. bot. Surv. India 4(1): 42 & 47, 1904.

Type (1)(?): Devimoneghat, North Kanara (Karnataka), *Talbot* 3732 (T).

No number is given in the protologue but since the specimen cited is from the type locality, it may be designated a type sheet.

MELIACEAE

Aglaia talbotii Sundararaghavan in Bull. bot. Surv. India 11 (1 & 2): 183-184, 1969.

A. littoralis Talb. Trees, shrubs & climbers Bombay Pres. (ed. 2) 76, 1902.

Holotype (1): Co-ompta, North Kanara (Karnataka), *Talbot* 2955 (T). *Paratype* (3): Co-ompta, North Kanara (Karnataka), *Talbot s.n.* (T): Karwar, North Kanara (Karnataka), *Talbot* 499-2955. (T).

Dysoxylum glandulosum Talb. Trees, shrubs & climbers Bombay Pres. (ed. 1) 39, 1894.

Syntype (6): Telgiri, North Kanara (Karnataka), *Talbot* 3808 (T).

Though no number is cited in the protologue, it is given here on the basis of Talbot's manuscript notes and of notes given on the sheets cited here.

OLACACEAE

Strombosia leprosa Talb. in J. Bombay nat. Hist. Soc. XI(2): 235, 1897 & (5): t. II, 1898.

Paratype (2): Yellapore, North Kanara (Karnataka), *Talbot s.n.* (T); Potolli, North Kanara (Karnataka), *Talbot* 1736 (T).

The specimens are not mentioned in the protologue but are listed here on the basis of Talbot's manuscript notes.

CELASTRACEAE

Gymnosporia konkanensis Talb. in For. Fl. Bombay Pres. Sind 1: 280, 1909.

Holotype (1): Monoli forest, Thana (Maharashtra), *Talbot s.n.* (T). *Paratype* (2): Parol forest, Bassein, Thana (Maharashtra), *Ryan*

1024; Tannah (Thana) (Maharashtra), *Talbot* 5155 (T).

Though no number is cited in the protologue, the holotype matches well with the illustration given there.

G. puberula Laws. in Hook. f. Fl. Brit. India 1: 619, 1875.

Type photo (1): Bombay, *Law s.n.* Kew Negative No. 6441 (1).

Salacia talbotii Gamble in Kew Bull. 1916: 133, 1916.

Syntype (1): North Kanara, *Talbot* 1217 (T).

Rhamnaceae

Ventilago maderaspatana Gaertn. var. **fructifida** Santapau in Kew Bull. 1949: 340, 1949.

Holotype (1) & *Isotype* (2): Khandala, Poona (Maharashtra), *Garade* 12(C).

Leeaceae

Leea talbotii King ex Talb. For. Fl. Bombay Pres. Sind 1: 329, 1909.

Holotype (1): Yellapore, North Kanara (Karnataka), *Talbot s.n.* (T). *Paratype* (3): Karwar, South Kanara (Karnataka), *Talbot s.n.* (T.).

Though no number is cited in the protologue, the holotype mentioned here matches perfectly with the illustrations.

Fabaceae

Alysicarpus vasavadae Hem. in Indian Forester 97(1): 65-69, 1971.

Isotype (4): Shivneri Fort Hill, Junnar, Poona (Maharashtra), *Hemadri* 104350 B-E. *Paratype*: Shivneri Fort Hill, Junnar, Poona (Maharashtra), *Rao* 83505 (2) & *Hemadri* 118101 (5); Kukdi river bank, Junnar, Poona (Maharashtra), *Hemadri* 104321 (3); Ganesh Caves, Junnar, Poona (Maharashtra), *Hemadri* 118132 (3).

Eleiotis trifoliata Cooke, Fl. Pres. Bombay 1: 342, 1902.

Syntype (3): Badami, Bijapur (Karnataka), *Cooke s.n.* (C).

Smithia agharkarii Hem. Indian Forester 97(1): 65-69, 1971.

Isotype (1): Dhak plateau, West of Junnar, Poona (Maharashtra), *Hemadri* 107486 B. *Paratype*: Hill above Tata Power Station, Khandala, Poona (Maharashtra), *Hemadri* 85171 A-I (9); Dhobi Falls, Mahableshwar, Satara (Maharashtra), *Mahajan* 24749 (1); Panchgani Road, Satara (Maharashtra), *Cooke s.n.* (1)(C).

Myrtaceae

Eugenia memecylifolia Talb. in J. Bombay nat. Hist. Soc. 11(2): 236, 1897 & (5): t. 5, 1898.

Holotype (1)& *Isotype* (3): Kalpa, North Kanara (Karnataka), *Talbot* 3127 (T).

E. utilis Talb. ibid. 11(2): 235, 1897 & (5): t. 3, 1898.

Holotype (1) & *Isotype* (1): Sonda, North Kanara (Karnataka), *Talbot* 3644 (T).

Syzygium kanarensis (Talb.) Raiz. in Indian Forester 74: 336, 1948. *Eugenia kanarensis* Talb. in J. Bombay nat. Hist. Soc. 11(2): 236, 1897 & (5): t.2, 1898.

Holotype (1): Mula muka, north Kanara (Karnataka), *Talbot* 3552 (T).

Apiaceae

Pimpinella katrajensis Rolla Rao et Hem. Indian Forester 102 (4): 232-34, 1976.

Isotype (6): Grown in Botanical Survey of India, Poona Garden, from the collections from Katraj Ghat, Poona (Maharashtra), *Hemadri* 108494 B-D & M-O. *Paratype*: Katraj Ghat, Poona (Maharashtra), *Hemadri* 81976 A-B (2); Panchgani, Satara (Maharashtra), *Ranade s.n.* (1)(C); Katraj Ghat, Poona (Maharash-

tra) *Cooke s.n.* (3) & *Bhide* 917 (1)(C).

Trachyspermum strictocarpum (C.B.Cl.) Wolff in Pfreich. 43: 89, 1927. *Pimpinella lateriflora* Dalz.; Hemadri in J. Bombay nat. Hist. Soc. 67(2): 355-357, 1970.

Neotype (6): Shivneri Fort, Junnar, Poona (Maharashtra), *Hemadri* 104346.

RUBIACEAE

Lasianthus sessilis Tab. Trees, shrubs & climbers Bombay Pres. (ed. 1): 114, 1894.

Holotype (1) & *Isotype* (1): Artabad, North Kanara (Karnataka), *Talbot* 1027 (T). *Paratype* (2): North Kanara (Karnataka), *Talbot* 266 (T).

Oldenlandia prainiana (Talb.) Craib in Kew Bull. 1910: 278, 1910. *Anotis prainiana* Talb. in J. Bombay nat. Hist. Soc. 11(2): 237, 1897 & (5): t. 6, 1898.

Holotype (1) & *Isotype* (4): Santaveri, Kadur, Chickmagalur (Karnataka), *Talbot* 2995 (T).

Psychotria canarensis Talb. Trees, shrubs & climbers Bombay Pres. (ed. 1): 113, 1894.

Holotype (1): Garsoppa, North Kanara (Karnataka), *Talbot* 257. *Paratype* (3): Garsoppa falls, North Kanara (Karnataka), *Talbot* 257-337, 337 & *s.n.* (T).

P. flavida Talb. ibid.: 113, 1894.

Holotype (1): Sonda, North Kanara (Karnataka), *Talbot* 3661 (T). *Paratype* (1): Nilkhurd, North Kanara (Karnataka), *Talbot* 3536 (T).

P. octosulcata Talb. in J. Bombay nat. Hist. Soc. 11(2): 237, 1897 & (5): t. VII, 1898.

Holotype (1): Siddapore, North Kanara (Karnataka), *Talbot* 3556 (T). *Paratype* (1): Without locality, *Talbot* 3764 (T).

Tarenna agumbensis Sundararaghavan in Bull. bot. Surv. India 10(3-4): 341-43, 1968.

Isotype (3): Barakana, Agumbe, Shimoga (Karnataka), *Sundara Raghavan* 62732 B-D.

ASTERACEAE

Blumea venkataramanii Rolla Rao et Hem. Curr. Science 42(19): 693-94, 1973.

Isotype (2): Vadgaon on Poona-Bombay Road, Poona (Maharashtra), *Hemadri* 118174 B-C. *Paratypes*: Pavnadam site near Vadgaon, Poona (Maharashtra), *Hemadri* 110794 A-C(3); Vadgaon, Poona (Maharashtra), *Hemadri* 108788 A-B (2); Ralegaon hills near Junnar, Poona (Maharashtra), *Hemadri* 68582 (1); Vanewade near Junnar, Poona (Maharashtra), *Hemadri* 68588 A-D (4).

Helichrysum cutchicum (C.B.Cl.) R. Rao et Desh. Bull. bot. Surv. India 10(2): 225-227, 1968. *Anaphalis cutchica* C.B.Cl. Comp. India 111, 1876.

Type photo (1): Kutch (Gujarat), *Dr. Stoliczka* 5396.

H. wightii C.B.Cl. in Hook. f. Fl. Brit. India 3: 291, 1881.

Type photo (1): Sisparaghat, Nilgherry hills (Tamil Nadu), Herb. R. Wight Prop. *Wight s.n.* Kew negative No. 5368.

Vernonia ornata Talb. in J. Bombay nat. Hist. Soc. 11(4): 691-92, t. XIII, 1898.

Holotype (1) & *Isotype* (1): Falls of Garsoppa, North Kanara (Karnataka), *Talbot* 2663 (T).

Though no number is cited in the protologue, the holotype matches well with the illustrations.

SYMPLOCACEAE

Symplocos kanarana Talb. ibid. 11(2): 238, 1897 & (5): t. IX, 1898.

Holotype (1): Ecunbi, North Kanara (Karnataka), *Talbot* 3673 (T). *Paratype* (1): Devimone ghat, North Kanara (Karnataka), *Talbot s.n.* (T).

ASCLEPIADACEAE

Ceropegia huberi Ansari in Bull. bot. Surv. India 10(2): 219-21, 1968.

Isotype (1) & *Paratype* (14): Ambaghat, Ratnagiri (Maharashtra), *Ansari* 105001 C & 105033 B-C & E-L & *Shevade s.n.* A-C (C).

C. mahabalei Hemadri et Ansari in Indian Forester 97: 105, 1971.

Isotype (4) & *Paratype* (2): Ralegaon, West of Junnar, Poona (Maharashtra), *Hemadri* 108070 B-E and 107266 A-B. *Paratype* (6): Hills adjoining Bhivade Khurd, Junnar, Poona (Maharashtra), *Hemadri* 107573 A-B & 117938 A-D.

C. noorjahaneae Ansari in J. Bombay nat. Hist. Soc. 69(1): 250-53, 1972.

Isotype (3) & *Paratype* (2): Wai-Panchgani ghat, Satara (Maharashtra), *Ansari* 104880 B-D & 105098 A-B.

C. rollae Hem. in Bull. bot. Surv. India 10: 223, 1968.

Isotype (7) & *Paratype* (10): Dhak Khilla, West of Junnar, Poona (Maharashtra), *Hemadri* 107471 B-C & I-L and 107547 A-B & E-L.

C. sahyadrica Ansari et Kulk. in Indian Forester 97 (2): 688-90, 1971.

Isotype (2): Ambolighat, Ratnagiri (Maharashtra), *Kulkarni* 108643 B-C. *Paratype* (12); Sinhagadh ("Singhar"), Poona (Maharashtra), *Garade* 57 A-C (C); Ambavne-Sakerpathar, Poona (Maharashtra), *Reddi* 98655, 98660, 98678, 99165 & 99212A; Ambolighat, Ratnagiri (Maharashtra), *Pataskar* 102141 A-B & *Kulkarni* 106321 A-B.

C. santapaui Wadhwa et Ansari in Bull. bot. Surv. India 10: 95, 1968.

Isotype (5) & *Paratype* (12): Mahabaleshwar-Mahad ghat road, Satara (Maharashtra), Wadhwa 109640 D & I-L and Wadhwa et Ansari 109651 B-D & I-O + one without alphabet.

Marsdenia lanceolata Cooke in Fl. Pres. Bomaby 2: 166, 1904.

Syntype (3): Lohagaon near Poona (Maharashtra), *Bhiva* (*babajee*) *s.n.* (C).

Seshagiria sahyadrica Ans. et Hem. in Indian Forester 97: 126, 1971.

Isotype (2): Sinhagad, Poona (Maharashtra), *Ansari* 87750 B-C. *Paratype* (5): Bhiwade Khurd, Durga hills, Junnar, Poona (Maharashtra), *Hemadri* 94360 A-B; Gureghar on Panchgani-Mahabaleshwar Road, Satara (Maharashtra), *Ansari* 105077 A-C.

CONVOLVULACEAE

Neuropeltis malabarica Van Ooststr. in Blumea 5 (1): 272, 1942.

Paratype (2): Potoli, North Kanara (Karnataka), *Talbot* 2735 (T).

ACANTHACEAE

Nilgirianthus membranaceus (Talb.) Bremek. *op. cit.* in Verh. Nederl. Akad. Wet. (II) 40(1): 280, 1944. *Strobilanthes membranaceus* Talb. Trees, shrubs, & climbers Bombay Pres. (ed. 2): 261, 1902.

Syntype (3): Anmode, North Kanara (Karnataka), *Talbot* 1616 (T).

Strobilanthes minor Talb. Trees, shrubs & Climbers Bombay Pres. (ed. 2): 262, 1902.

Holotype (1) *Isotype* (2): Kala Nuddi, Supa, North Kanara (Karnataka), *Talbot* 1338 (T).

LAMIACEAE

Leucas angustissima Sedgwick in J. Indian Bot. 2(3): 124, 1921.

Syntype (1): Siddapore, North Kanara (Karnataka), *Talbot* 3740 (T).

L. deodikarii Bill. et Hem. in Indian Forester 96: 858, 1970.

Isotype (1): Dhak Khilla, Junnar, Poona (Maharashtra), *Hemadri* 117970 B. *Paratype*: B.S.I. Experimental Garden, Poona (Maharashtra), *Billore* 115985 A-C & M-O (6); Foot of Ras Cha Jungle near Gadad, Khed Taluka,

Poona (Maharashtra), *Janardhanan* 76249 A-B (2): Ghatghar, Junnar, Poona (Maharashtra), *Hemadri* 120584 A-B (2); Bhivade Khurd, Junnar, Poona (Maharashtra), *Hemadri* 117933 A-B (2); Balighat near Tombe, Junnar, Poona (Maharashtra), *Hemadri* 117830 A-B (2); Malvand dara, Bhivade Khurd, Junnar, Poona (Maharashtra), *Hemadri* 107555 A-B (4) & 118025 (1); Ghat top (Vinchu Cha Nal) near Igatpuri, Thana (Maharashtra), *Billore* 110557 A-B (2), 116170 A-E (5) & 116796 A-B (2); Kedarnath Hill slope, Harishchandragarh, Thane (Maharashtra), *Billore* 115621 A-B (2).

Plectranthus parvifolius Talb. in J. Bombay nat. Hist. Soc. 11(2): 238, 1897 & (5): t. 10, 1898.

Paratype (1): Jungles W. Potolli, North Kanara (Karnataka), *Talbot* 1739 (T).

It is given here on the basis of Talbot's manuscript notes.

POLYGONACEAE

Polygonum hydropiper Linn. var. **glandulosissima** Cage in Rec. Bot. Surv. India 2: 401, 1903.

Isotype (2): Dandeli, North Kanara (Karnataka), *Talbot* 2682 (T).

LAURACEAE

Cryptocarya procera Talb. in For. Fl. Bombay Pres. Sind 2: 385, 1911.

Holotype (1): Nilkund, North Kanara (Karnataka), *Talbot* 2872 (T).

Though no number is cited in the protologue, the specimen is mentioned here on the basis of Talbot's manuscript notes.

LORANTHACEAE

Dendropthoe gibbosa (Talb.) Razi in Lloydia 20: 242, 1957. *Loranthus gibbosus* Talb. in Trees, shrubs & climbers Bombay Pres. (ed. 2): 289, 1902.

Type (1): Yellapore, North Kanara (Karnataka), *Talbot s.n.* (T).

Since the specimen cited is from the type locality, it may be a type sheet.

Viscum mysorense Gamble in Kew Bull. 1925; 329, 1925.

Type photo (1): Araikere, Hassan (Karnataka), *Meebold* 8207.

V. trilobatum Talb. in For. Fl. Bombay Pres. Sind 2 : 419—20, 1911.

Holotype (1): Yellapore, North Kanara (Karnataka), *Talbot s.n.* (T).

Though no number is mentioned in the protologue, the said specimen matches with the illustration given there.

BALANOPHORACEAE

Acroblastum ambavanense Reddi in Willdenowia 5/3 : 389—93, 1969.

Isotype (1): Kate Pani Forest near Ambavane Village, Poona (Maharashtra), *Reddi* 99494 b.

EUPHORBIACEAE

Euphorbia katrajensis Gage in Kew Bull. 1914 : 236, 1914.

Syntype (2): Katraj hills, Poona (Maharashtra), *Kanetkar s.n.* (C); Katraj ghats, Poona (Maharashtra), *Shevade* s.n. (C).

Phyllanthus talbotii Sedgwick in J. Indian Bot. 2(3): 124, 1921.

Syntype (1): Falls of Garsoppa, North Kanara (Karnataka), *Talbot* 828 (T).

URTICACEAE

Ficus talbotii King, Sp. Fic. in Ann. Roy. Bot. Gard. Calcutta 1 : 51, t. 63 & 84, Fig. Q, 1888.

Syntype (2): Sircy & Yenna rocks, North Kanara (Karnataka), *Talbot* 655 & 1100 (T).

HYDROCHARITACEAE

Blyxa talbotii Hook. f. in Fl. Brit. India 5: 661, 1888.

Isotype (2): North Kanara (Karnataka), *Talbot* 920 (T).

ORCHIDACEAE

Dendrobium mabelae Gammie in J. Bombay nat. Hist. Soc. 16(4): 567, 1905.

Type (1)(?): Castle rock, North Kanara (Karnataka), *Gammie* s.n. (C).

No number is cited in the protologue but since this is Gammie's specimen, collected prior to his publication of this species, it may be a type sheet.

LILIACEAE

Chlorophytum bharuchae Ans., Raghavan et Hem. in Indian Forester 96: 304, 1970.

Isotype (5) & *Paratype* (7): Shivneri fort, Junnar, Poona (Maharashtra), *Ansari* 88712 B-F (5), *Hemadri* 107097 (3) & 94310 (4).

COMMELINACEAE

Cyanotis arcotensis Rolla Rao in Blumea XIV (2): 345—48, 1966.

Isotype (1): Tippu kadu R.F., North Arcot Dist. (Tamil Nadu), *Joseph* 89886B.

C. cerifolia Rolla Rao et Kammathy in J. Linn. Soc. Bot. 59 (379): 305, 1966.

Isotype (1): Experimental Garden of the Circle, Poona (Maharashtra), *Kammathy* 77785 B. *Paratype* (1): Waverly Estate, Anamalis (Kerala), *Kammathy* 73950 A.

ARACEAE

Arisaema caudatum Engler emend Rolla Rao & Ahuja in Bull. bot. Surv. India 11 (3-4): 450—52, 1969.

Isoneotype (2): Panchgani Plateau, Satara (Maharashtra), *Ansari* 105095 B.

ERIOCAULACEAE

Eriocaulon horsley-kundae Fyson in J. Indian Bot. Soc. 3 : 13, 1922.

Isotype (1): Guddapah (Andhra Pradesh), *Gamble* 20985 (T).

CYPERACEAE

Cyperus pentabracteatus Govind. et Hem. in Proc. Ind. Acad. Sci. 82 (B)(6): 205—210, 1975.

Isotype (1): Durga Khilla plateau, Junnar, Poona (Maharashtra, *Hemadri* 107562 B.

Fimbristylis unispicularis Govind. et Hem. *ibid.* 205—210, 1975.

Isotype (3): Durga khilla plateau, Junnar, Poona (Maharashtra), *Hemadri* 107528 B-D.

F. woodrowii Clarke in J. Linn. Soc. 34 : 68, 1899.

Syntype (2): Khandala, Poona (Maharashtra), *Woodrow* s.n. (C).

POACEAE

Arthraxon deccanensis Jain in J. Bombay nat. Hist. Soc. 68 : 297—99, 1971.

Paratype (2): Sinhagad, Poona (Maharashtra), *Vartak* 5884/6; Sitabai Dara, Arvi, Haveli, Poona (Maharashtra), *Ansari* 99978.

A. junnarensis Jain et Hem. ibid. 68 : 300—301, 1971.

Isotype (2): Warsubai, Junnar, Poona (Maharashtra), *Hemadri* 106849 B-C. *Paratype* (2): Wilson Point Road, Mahabaleshwar, Satara (Maharashtra), *Mahajan* 27170 A-B.

A. lancifolius (Trin.) Hochst. var. **hindus-**

tanicus Jain et Desh. in J. Indian bot. Soc. 51(2): 176, 1972.

Isotype (3): Chapora, Kaisuva fort (Parvorim), Goa, *Cherian* 88557 B-D. *Paratype* (4): Ganesh Caves, Junnar, Poona (Maharashtra), *Hemadri* 118151 A-B; Ajoba hill slope, Washala range, Thane (Maharashtra), *Billore* 111947 A-B.

A. raizadae Jain, Hem. et Desh. in J. Indian bot. Soc. 51(2): 103—6, 1972.

Isotype (3): Mahabaleshwar, Satara (Maharashtra), *Hemadri* 98585 B-D. *Paratype*: Mahabaleshwar, Satara (Maharashtra), *Hemadri* 98546 A-D (4), 98550—A-E (5), *Mahajan* 24757 (1) (Dhobi Falls), 13048 (2) (Near Venna Lake), 24725 (1) (Babington Point), *Ansari* 67704 (2) (Lingmala Falls area), 67571 (2) Old Mahabaleshwar Road), 67663 (2) (Along Mahad road ghat), *Kanodia* 87054 & 87059 (4) (Near Gureghar Nursery), & *S. R. Rolla* 71739 (2) (on way to Pratapgad).

Bhidea burnsiana Bor in Kew Bull. 1948: 445, 1949.

Isotype (2): Lonavla, Poona (Maharashtra), *Bhide* 20724 (C).

Bothriochloa jainii Deshp. et Hem. in Indian Forester 97(10): 593, 1971.

Isotype (2): Durga hills, Junnar, Poona (Maharashtra), *Hemadri* 104241B—C. *Paratype*: Junnar, Poona (Maharashtra), *Hemadri* 120572 (2) (Ghatghar), 104401(2) (Durga khilla), 108222 (2) (Dhak Khilla) & *Vartak* 11944 (1) (Raireshwar); Tiskari Forest outskirts, Ambavane, Poona (Maharashtra), *Reddi* 95800 (6); Top of Masgaon hill, Ambavane, Poona (Maharashtra), *Reddi* 99471 (2); Lingmala Falls, Mahabaleshwar, Satara (Maharashtra), *Mahajan* 13075 (6); Taramati Hill slope, Harishchandragad, Thana (Maharashtra), *Billore* 115689 (3).

Capillipedium magdaleni Almeida in J. Bombay nat. Hist. Soc. 72(3): 813—14, 1975.

Isotype (1): Agumbe, Shimoga (Karnataka), *Almeida* 2941.

Cynodon barberi Rang. & Tad. ibid. 24: 846, 1916.

Syntype (1): Coimbatore (Tamil Nadu), *Rangachari & Tadulingam s.n.* (C).

Danthonidium gammiei (Bhide) C. E. Hubb. in Hook. Ic. Pl. subtab. 3331, 1937.

Danthonia gammiei Bhide in J. et Proc. Asia. Soc. Bengal n.s. 7: 513, 51, t. 6, 1911 (1912).

Holotype (1) & *Isotype* (1): Castle rock, North Kanara (Karnataka), *Gammie* 15636 (C).

Dimeria santapaui Almeida in J. Bombay nat. Hist. Soc. 66: 510, 1969.

Isotype (1): Mirjan Flats, North Kanara (Karnataka), *Sedgwick & Bell* 6875.

D. woodrowii Stapf in Hook. Ic. Pl. subtab. 2312, 1894.

Isotype (4): Marmagoa, Goa, *Talbot* 2557 (T).

Enteropogon monostachyos (Vahl) K. Schum. ex Engl. in Abh. Preuss. Akad. Wiss. 17, 1894 et in Planzenw. Ost-Afr. C, 110, 1895. *E. badamicus* Bhide in J. et Proc. Asia. Soc. Bengal, n.s. 7: 514, 1911 (1912).

Isotype (14): Badami, Bijapur (Karnataka), *Bhide s.n.* (C).

Isachne borii Hemadri in Indian Forester 97: 223, 1971.

Isotype (4): Dhak plateau, Junnar, Poona (Maharashtra), *Hemadri* 117968 B-E. *Paratype* (3): Plateau above Bushi Lake, Lonavla, Poona (Maharashtra), *Reddi* 98672 A-C.

I. mysorensis Sundararaghavan, ibid. 97(6): 304—07, 1971.

Isotype (4): Kandadagudda near Agumbe, Shimoga (Karnataka), *Sundararaghavan* 90008 B-E.

Ischaemum raizadae Hem. et Bill. ibid. 96:

318, 1970.

Isotype (11): Sadryaghat near Harishchandragarh, Thana (Maharashtra), *Billore* 115450 C-F & I-O. *Paratype*: B.S.I. Exp. Garden, Poona (Maharashtra), *Billore* 115984 A-E & G-Q (15); Ambolighat, Ratnagiri (Maharashtra), *Kulkarni* 119225 A-F (6); Amba, Ratnagiri (Maharashtra), *Bhide* 15 A-B (2) (C); Ambewadi, Nasik (Maharashtra), *Patwardhan* 1115 (C).

Lasiurus ecaudatus Satya. et Shank. in J. Bombay nat. Hist. Soc. 60(3): 763-66, 1963.

Isotype (1): G. R. Farm, Jodhpur (Rajasthan), *Satyanarayan & Shankarnarayan* 719.

Manisuris acuminata (Hack.) O. Ktze. var. **woodrowii** Bor in Grass. Burma, Ceylon, India & Pakistan 191, 1960.

Syntype (4): Vasco-da-Gama, Goa, *Bhide s.n.* (C).

M. forficulata Fischer emend. Jain in Bull. bot. Surv. India 12(1-4): 12-14, 1970.

Paratype (2): Ambolighat, Ratnagiri (Maharashtra), *Talbot* 4305 C/2 (T).

M. goaensis Rolla Rao et Hem. ibid. 10: 106, 1968.

Isotype (2): Near Verna village in Cortalim—Madgao Road, Goa, *Rolla S. Rao* 84474 B-C. *Paratype* (2): Near Porvorim village, Goa, *Rolla S. Rao* 92850 B & D.

M. mysorensis Jain et Hem. ibid. 10: 280-82, 1968.

Isotype (1): Castle rock, North Kanara (Karnataka), *Gammie* 15643 (C). *Paratype* (1): Ambolighat, Ratnagiri (Maharashtra), *Talbot* 4305 (T).

M. ratnagirica Kulk. et Hem. in Indian Forester 100: 250, 1974.

Isotype (5): Chakul Road, Ambolighat, Ratnagiri (Maharashtra), *Kulkarni* 121638 B, D, M, N & O. *Paratype* (7): Soliya jungle, Amboli, Ratnagiri (Maharashtra), *Kulkarni* 119190 A-D & I-K.

M. santapaui Jain et Deshp. in Bull. bot. Surv. India 10 (3-4): 277-79, 1968.

Isotype (1): Ratnagiri (Maharashtra), *Saldanha* C5/7130 B.

M. talbotii (Hook. f.) Bor, Grass. Burma, Ceylon, India & Pakistan 192, 1960.

Rottboellia talbotii Hook. f. in Fl. Brit. India 7: 155, 1896.

Isotype (1): Marmagoa, Goa, *Talbot* 2572 (T).

Oropetium roxburghianum (Steud.) S. M. Philips. Kew Bull. 30(3): 469, 1975.

Tripogon roxburghianus (Steud.) Bhide in J. et Proc. Asiat. Soc. Bengal m.s. 7: 515, 1911 (1912).

Isotype (4): Badami Fort, Bijapur (Karnataka), *Bhide, s.n.* (C).

Oryza malumpuzhaensis Krish. et Chandr. in Madras Agric. J. 45: 471-72, 1958.

Isotype (1): Palghat, Kerala, *Krishnaswamy & Chandrasekharan s.n.*

Pogonachne racemosa Bor in Kew Bull. 1949: 176, 1949.

Isotype (1): Matheran, Colaba (Maharashtra), *Woodrow s.n.* (C).

Schizachyrium paranjpyeanum (Bhide) Raiz. et Jain in Proc. Indian Sci. Congr. abstracts III: 130, 1953. *Andropogon paranjapyeanum* Bhide in J. et Proc. Asia. Soc. Bengal, n.s. 7: 514, 1911 (1912).

Syntype (3): Castle rock, North Kanara (Karnataka), *Bhide s.n.* (C).

ACKNOWLEDGEMENTS

We are thankful to Dr. S. K. Jain, Joint Director-in-charge, Botanical Survey of India, Howrah for facilities & to Dr. M. P. Nayar, Deputy Director, Western Circle, Poona for encouragement and also for kindly going through the manuscript.

REVISED NOMENCLATURE FOR TAXA IN WYNTER-BLYTH'S BOOK ON THE BUTTERFLIES OF INDIAN REGION

R. K. VARSHNEY[1]

INTRODUCTION

The BUTTERFLIES OF THE INDIAN REGION by M. A. Wynter-Blyth (1957, Bombay Natural History Society; 1st ed., 523 pp., 27 coloured and 45 black-and-white pls.) is still the latest book on its subject. On account of its life-like illustrations, keys, and details of habits and habitats recorded, this book will remain a companion to the novice as well as expert butterfly collector, for a long time to come.

Unfortunately, the scientific names used in this book for the butterfly genera and species, are in many cases old and invalid, according to the rules of Zoological nomenclature. Although this book was published in 1957, it appears to me that its text was probably prepared during early forties. Many of the scientific names then valid have later turned out to be synonyms. Hence, a revision has become quite essential. That these changes were felt necessary even at the stage of printing of this book itself, is evident from such entries made in three families, Papilionidae, Pieridae and Hesperiidae: "Genus *Zetides* (now *Graphium*)" [p. 400], "*Colotis protractus* (Butler), now *C. phisadia* (Godart)" [p. 439], "*Baoris oceia* (now *B. farri*)" [p. 484] etc. These corrections are obviously inadequate and incomplete.

[1] Gangetic Plains Regional Station, Zoological Survey of India, Rajendra Nagar, Patna (Bihar). *Present address*: Superintending Zoologist, Zoological Survey of India, 34 Chittaranjan Avenue, Calcutta-700 012.

Therefore, I have prepared a list of all such names given in this book, in which either the genus name, or species name, or the latter's author name, requires correction; and alongwith provided the present valid name of that taxa. If a particular subspecies, other than nominal subspecies, has been found to completely cover the geographical distribution shown by Wynter-Blyth for a species, then it has been added in the revised nomenclature. The page numbers of his book are cited on the left, for ready reference. It may be stated that all those genera and species, which do not require any change in their nomenclature, have been left out. Besides, no attempt has been made to show all subspecies under a species. I have, however, given explanatory taxonomic notes on some major changes, in the beginning of each family. In the present paper, only five families have been covered. It is hoped that remaining families will be dealt with in subsequent contributions.

It is hoped that these notes and lists of revised nomenclature for the taxa of butterflies from India and other neighbouring countries, would be useful to the workers on butterflies in general and to those consulting Wynter-Blyth's book in particular.

Family DANAIDAE

Three genera are known from the Indian region. Wynter-Blyth has given their names as *Hestia, Danais* and *Euploea*. *Hestia* Hübner, 1816, is a synonym of *Idea* Fabr., 1807 [*vide* Talbot, 1941, *Trans. R. ent. Soc. Lond. 91*

(4): 105-117]. *Danais* Latr., 1807, is a synonym of *Danaus* Kluk, 1802, as per Opinion No. 278, of 1954, of the International Commission of Zoological Nomenclature. I have elsewhere given details of this case and indicated that Kluk published *Danaus* for the first time in 1780 and his 1802 work is a subsequent citation [Varshney, 1973, *Curr. Sci.* *42* (19): 698-699].

The common tiger butterfly of this region has been referred by two different names in the literature: *Danaus plexippus* (Linn.) and *D. genutia* (Cramer). Talbot [1947, FAUNA OF BRITISH INDIA—Butterflies, 2nd ed., *2*], whom I have largely followed for revision of this family, has chosen the name *plexippus* and I differ in this case. It is now well established that the type specimens of *plexippus* named by Linnaeus came from North America; hence, that American species, the monarch, has presently *D. plexippus* as its valid name. The Indo-Oriental species has been found to be quite different from that American species, thus it should be appropriately referred as *D. genutia,* the next oldest name applied to it. My conclusion is in agreement with the decision of the International Commission, now widely accepted [*vide* Editors, 1960, *J. Bombay nat. Hist. Soc. 57* (1): 230-231].

The correction of the case-ending *-ii* to *-i* in all patronymic names formed after male persons has been introduced by me, in accordance with rules. [see Table 1].

TABLE 1

DANAIDAE

	Page No.	For	Correct
1.	64	Genus *Hestia* [Hübner]	Genus *Idea* Fabricius
2.	„	*Hestia lynceus* Moore & de Niceville	*Idea lynceus* (Drury)
3.	64-70	Genus *Danais* [Latreille]	Genus *Danaus* Kluk
4.	65	*Danais aglea* (Cramer)	*Danaus aglea* (Stoll)
5.	66	*Danais tytia* (Gray)	*Danaus sita sita* (Kollar)
6.	67	*Danais fumata* Butler	*Danaus taprobana* (C. & R. Felder)
7.	„	*Danais limniace* Cramer	*Danaus limniace leopardus* (Butler)
8.	68	*Danais melissa* (Cramer)	*Danaus hamata* (McLeay)
9.	69	*Danais plexippus* (Linnaeus)	*Danaus genutia* (Cramer)
10.	„	*Danais melanippus* (Cramer)	*Danaus melanippus indicus* (Frühstorfer)
11.	71	*Euploea alcathoe* (Godart)	*Euploea doubledayi doubledayi* C. & R. Felder
12.	72	*Euploea crameri* Moore	*Euploea crameri* Lucas
13.	73	*Euploea coreta* (Godart)	*Euploea sylvester coreta* (Godart)
14.	„	*Euploea crassa* Butler	*Euploea klugi erichsoni* C. & R. Felder
15.	74	*Euploea godarti* Lucas	*Euploea core godarti* Lucas
16.	„	*Euploea corus* (Fabricius)	*Euploea phaenareta corus* (Fabricius)
17.	76	*Euploea deione* Westwood	*Euploea algea deione* Westwood
18.	„	*Euploea harrisi* Felder	*Euploea sylvester harrisi* C. & R. Felder
19.	„	*Euploea diocletiana* (Fabricius)	*Euploea diocletianus* (Fabricius)
20.	77	*Euploea klugii* Moore	*Euploea klugi klugi* Horsfield & Moore

Family SATYRIDAE

The nomenclature used by Wynter-Blyth for the taxa of this family are generally valid. However, in three genera, *Mycalesis, Lethe* and *Ypthima,* he has not provided the names of authors of the species included. These may be found in Talbot [1947, FAUNA OF BRITISH INDIA—Butterflies, 2nd ed., *2*: 110-344].

Major generic changes in the present list are as follows: *Eumenis* Hübner, 1819, is a synonym of *Hipparchia* Fabr., 1807, with its spe-

TABLE 2

SATYRIDAE

	Page No.	For	Correct
1.	83	*Mycalesis francisca* (Cramer)	*Mycalesis francisca* (Stoll)
2.	84	*Mycalesis gotama* Moore	*Mycalesis gotama charaka* Moore
3.	„	*Mycalesis orseis* Hewitson	*Mycalesis orseis nautilus* Butler
4.	86	*Mycalesis subdita* (Moore)	*Mycalesis visala subdita* (Moore)
5.	87	*Mycalesis mercea* Evans	*Mycalesis igilia mercea* Evans
6.	„	*Mycalesis khasia* Evans	*Mycalesis intermedia* (Moore)
7.	90	*Mycalesis mamerta*	*Mycalesis annamitica* Frühstorfer
8.	94	*Lethe distans* race *nilgiriensis*	*Lethe rohria neelgheriensis* (Guérin)
9.	„	*Lethe distans* race *dyrta*	*Lethe rohria rohria* (Fabricius)
10.	„	*Lethe distans* race *rohria*	*Lethe rohria rohria* (Fabricius)
11.	97	*Lethe sinoryx*	*Lethe sinorix* (Hewitson)
12.	100	*Lethe violaceopicta*	*Lethe violaceopicta kanjupkula* Tytler
13.	„	*Lethe ocellata*	*Lethe ocellata lyncus* de Nicéville
14.	„	*Lethe gemina*	*Lethe gemina gafuri* (Tytler)
15.	102	*Lethe armandii*	*Lethe armandii khasiana* (Moore)
16.	„	*Lethe badra*	*Lethe bhadra* (Moore)
17.	103	*Pararge moorei* (Butler)	*Rhaphicera moorei* Butler
18.	104	*Pararge satricus* (Doubleday)	*Rhaphicera satricus* (Doubleday)
19.	106	*Coenonympha myops* Staudinger	*Coenonympha myops macmahoni* (Swinhoe)
20.	106-108	Genus *Eumenis* [Hübner]	Genus *Hipparchia* Fabricius
21.	107	*Eumenis mnizechii* Herrich-Schaffer	*Hipparchia mniszechii* (Herrich-Schaffer)
22.	108	*Eumenis persephone* (Hübner)	*Hipparchia persephone enervata* (Staudinger)
23.	„	Genus *Karanasa* [Moore]	Genus *Hipparchia* Fabricius
24.	113	*Erebia shallada* Lang	*Erebia shallada* Marshall & de Nicéville
25.	115	*Ypthima asterope*	*Ypthima asterope mahratta* Moore
26.	116	*Ypthima hübneri*	*Ypthima ceylonica huebneri* Kirby
27.	117	*Ypthima avanta*	*Ypthima lisandra* (Cramer)
28.	121	*Coelites nothis* (Boisduval)	*Coelites nothis adamsoni* Moore
29.	122	*Neorina patria* Leech	*Neorina patria westwoodi* Moore
30.	„	Genus *Anadebis* [Butler]	Genus *Ethope* Moore
31.	„	*Melanitis leda* (Drury)	*Melanitis leda ismene* (Cramer)
32.	123	*Melanitis phedima* Cramer	*Melanitis phedima* (Stoll)
33.	127	*Elymnias singala* Moore	*Elymnias singhala* Moore
34.	128	*Elymnias nesaea* (Hewitson)	*Elymnias nesaea* (Linnaeus)
35.	129	*Elymnias pealii* Wood-Mason	*Elymnias peali* Wood-Mason
36.	„	*Elymnias penanga* (Westwood)	*Elymnias penanga chelensis* de Nicéville

cies falling under *Dryas* group. *Karanasa* Moore, 1893, is also a synonym of *Hipparchia* Fabr., with its species falling under *Actaea* group. Genus name *Anadebis* Butler, 1867, was proposed as a new name for genus *Theope* Moore, 1857, which was preoccupied. However, a replacement name *Ethope* Moore, 1866, was published by Moore himself as a substitute for *Theope*, before the publication of *Anadebis*. Hence, *Anadebis* is suppressed in favour of *Ethope*.

Although Talbot (loc. cit.) has been generally followed, however, his attempt to change *Ypthima watsoni* to *Y. pandocus watsoni* is not adopted here, in view of the study by Cantlie & Norman [1959, *J. Bombay nat. Hist. Soc. 56*: 66]. The species-group name *Y. hübneri* is corrected by me as *huebneri*, under the provisions of Article 32(c)(i) of nomenclature rules. [see Table 2].

Family AMATHUSIIDAE

Nine genera are included by Wynter-Blyth in this family. The names used for all of them are correct and valid, except one genus, '*Sticopthalma*' or '*Stichopthalma*' (sic). It seems Wynter-Blyth followed Evans [1932, THE IDENTIFICATION OF INDIAN BUTTERFLIES, 2nd ed. : 132] who has also erroneously spelt it. It should be correctly spelt as *Stichophthalma* [*vide* Hemming, 1934, *Generic names of Holarctic Butterflies*:51].

Among the species names, some changes in the present list are as follows: *Stichophthalma sparta* is now considered as a subspecies of *S. louisa*, but it is recorded from North-Eastern Burma only; while the subspecies found from Assam to Burma is *S. l. tytleri* [Talbot, 1947, FAUNA OF BRITISH INDIA—Butterflies, 2nd ed., *2*: 421-423]. *Thauria lathyi* is presently considered as one subspecies of *T. aliris*, and its distribution is restricted to Southern Shan States of Burma. *Discophora tullia* has been merged in *D. sondaica zal*, but since Wynter-Blyth has shown wide distribution of *tullia*, I am unable to restrict it to that subspecies only. *Faunis arcesilaus* has been found as an invalid name and substituted with *canens arcesilas*, following Stichel [1933, LEP. CAT.—Amathusiidae, *54*: 73]. [See Table 3].

TABLE 3

AMATHUSIIDAE

	Page No.	For	Correct
1.	132	*Faunis arcesilaus* (Fabricius)	*Faunis canens arcesilas* Stichel
2.	133	Genus *Sticopthalma*	Genus *Stichophthalma* Felder (C.) & Felder (R.)
3.	,,	*Stichopthalma sparta* Tytler	*Stichophthalma louisa tytleri* Rothschild
4.	134	*Thaumantis diores* Westwood	*Thaumantis diores* Doubleday
5.	,,	*Thauria lathyi* Frühstorfer	*Thauria aliris* (Westwood)
6.	,,	*Amathusia phidippus* (Johanssen)	*Amathusia phidippus* (Linnaeus)
7.	135	*Discophora tullia* (Cramer)	*Discophora sondaica* Boisduval
8.	138	*Discophora continentalis* Moore	*Discophora timora timora* Westwood

Family Papilionidae

The nomenclature of Papilionid butterflies included in Wynter-Blyth's book needs to be revised on large scale. Most of the generic names of this family used there, are now considered as invalid, while some groups of species need to be transferred en-bloc from one generic name to another, thus, changed combinations for many species will result, as indicated in the list below (Table 4).

Changes in the names of genera are as follows: *Armandia* Blanchard is preoccupied and should be substituted by *Bhutanitis* Atkinson. *Tros* Kirby, used by Wynter-Blyth and earlier by Evans in their books, was replaced with *Polydorus* Swainson, by Talbot [1939, FAUNA OF BRITISH INDIA-Butterflies, 2nd ed., *1*: 70] reporting that it is the oldest name among several synonyms of this genus. However, *Polydorus* also proved to be a preoccupied name. Corbet [1943, *Entomol. 76*: 206] stated that it should be substituted by *Atrophaneura* Reakirt, with which Talbot [1947, op. cit. *2*: 490] agreed. Contrastingly, Eugene Munroe [1961, *Can. Ent. 93* suppl. 17] has replaced *Polydorus* by another name *Pachlioptera* Reakirt. On examining the case, I have observed that (i) *Pachlioptera* is an incorrect subsequent spelling of *Pachliopta* Reakirt; (ii) both

Table 4

Papilionidae

	Page No.	For	Correct
1.	373-378	Genus *Tros* [Kirby] (now *Polydorus*)	Genus *Atrophaneura* Reakirt
2.	378	*Tros alcinous* (Klug) now *plutonius* (Oberthür)	*Atrophaneura plutonius* (Oberthür)
3.	379-381	Genus *Chilasa* [Moore]	Genus *Papilio* Linnaeus (*Clytia* Group)
4.	380	*Chilasa paradoxa* (Zinken-Sommer)	*Papilio paradoxa telearchus* Hewitson
5.	384	*Papilio memnon* Linnaeus	*Papilio memnon agenor* Linnaeus
6.	386	*Papilio elphenor* Doubleday	*Papilio elephenor* Doubleday
7.	392	*Papilio polytes* Linnaeus	*Papilio polytes romulus* Cramer
8.	397-400	Genus *Pathysa* [Reakirt] (now *Graphium*)	Genus *Graphium* Scopoli
9.	400-404	Genus *Zetides* [Hübner] (now *Graphium*)	Genus *Graphium* Scopoli
10.	402	*Zetides evemon* (Boisduval)	*Graphium evemon albociliatis* (Fruhstorfer)
11.	403	*Zetides euryplus* (Linnaeus)	*Graphium eurypylus cheronus* (Fruhstorfer)
12.	„	*Zetides bathycles* (Zinken-Sommer)	*Graphium bathycles chiron* (Wallace)
13.	404-405	Genus *Paranticopsis* [De Nicéville & Wood-Mason] (now *Graphium*)	Genus *Graphium* Scopoli
14.	406	Genus *Meandrusa* [Moore] (now *Graphium*)	Genus *Graphium* Scopoli
15.	„	*Meandrusa payeni* (Boisduval)	*Graphium payeni evan* (Doubleday)
16.	407	Genus *Leptocircus* [Swainson] (now *Lamproptera*)	Genus *Lamproptera* Gray
17.	408	Genus *Armandia* [Blanchard]	Genus *Bhutanitis* Atkinson

of these replacement names, *Atrophaneura* and *Pachliopta*, have been published in a single paper, entitled, 'Notes upon exotic Lepidoptera, chiefly from the Philippine Islands, with descriptions of some new species', by Reakirt [1865 (1864), *Proc. ent. Soc. Philadelphia 3*: 443-504]; and (iii) being published in the same work and on the same date, the relative precedence is to be accorded on the choice made by the first reviser, according to the rules of nomenclature. In this case, *Atrophaneura* has been chosen by Corbet [1943, loc. cit.] and Hemming [1964, *Annot. Lep. 3*: 84]. Hence, *Atrophaneura* shall have to be taken as the valid name of this genus.

Four generic names, *viz., Pathysa* Reakirt, *Zetides* Hübner, *Paranticopsis* De Nicéville & Wood-Mason, and *Meandrusa* Moore, which have been used in the book by Wynter-Blyth, have all been merged as synonyms of the genus *Graphium* Scopoli [*vide,* Hemming, 1934, GENERIC NAMES OF HOLARCTIC BUTTERFLIES: 151], and indication to this change has been made in Wynter-Blyth's book also. Peile [1937, A GUIDE TO COLLECTING BUTTERFLIES IN INDIA: 20-39] has treated *Graphium* and 5 other genera as merely "groups of the genus *Papilio* Linn.", but his action has not been followed by later workers in the case of *Troides, Polydorus* (now *Atrophaneura*), and *Graphium*. *Chilasa* Moore was also treated as a separate genus by Talbot [1939, loc. cit.], but he later on [Talbot, 1947, ibid. 2 : 491] relegated it to the position of a "species group of *Papilio*", following Ford [1944, *Trans. R. ent. Soc. London, 94*: 206]. Generic name *Leptocircus* Swainson has been found invalid and a junior objective synonym of *Lamproptera* Gray [Hemming, 1934, ibid.: 153].

Among species names, only one case requires comment. Talbot [1947, ibid. 2: 491] has reported that the species name *Polydorus aristolochiae* (Fabr.) is strictly preoccupied by *Atrophaneura ascanius* (Linn.) and that the Indian subspecies will be *diphilus* (Esper). This change has not been followed by me, because the specific name *aristolochiae* (Fabr.) has been upheld by the International Commission of Zoological Nomenclature, in its Opinion No. 265, in 1954.

The subspecies names in this series have been given in such cases only, where either a subspecies, other than nominal, occurs within the whole Indian region, or where the geographical distribution shown by Wynter-Blyth for a species, has been found to clearly indicate any particular subspecies. [See Table 4].

Family PIERIDAE

Jiri Paclt pointed out the philological inconvenience of this family name Pieridae and suggested that in accordance with its type genus *Pieris,* the grammatically correct and valid name would be Pierididae. Hemming, however, did not like this change and as Secretary to the International Commission on Zoological Nomenclature, he arranged the use of Plenary powers to validate the spelling "Pieridae" as against "Pierididae" [vide, Hemming, 1956, *Bull. zool. Nomencl., 12*: 291-306].

Among the generic names of this family used in the book by Wynter-Blyth, the following changes are indicated here: *Huphina* Moore, 1881, is invalid and found to be a junior synonym of *Cepora* Billberg, 1820. *Belenois* Hübner, 1819, has been merged in *Anaphaeis* Hübner, 1819. I further observe that Talbot [1939, FAUNA OF BRITISH INDIA—Butterflies, 2nd ed., *1*] has spelt it as *Anapheis* throughout; and given Klots as author of *Belenois,* but Hemming [1967, *Bull. Br. Mus. nat.*

Hist., Ent. Suppl. 9: 42] shows that the original lettering is *Anaphaeis*, and the author of *Belenois* is Hübner. Generic name *Parenonia* was proposed by Bingham [1907, FAUNA OF BRITISH INDIA—Butterflies, 1st ed., *2*: 276] to replace *Valeria* Horsfield, 1829, which Bingham thought erroneous due to the tautonymy in the name of genus and its type species, *valeria* Cramer. This being untenable, the name *Valeria* Horsfield is restored. Genus *Terias* Swainson, 1821, is synonymous with *Eurema* Hübner, 1819; vide, Talbot 1939 [op. cit.] which has been largely followed for revision of this Part.

A confusion exists regarding validity between the two species names, *nerissa* Fabricius and *coronis* Cramer, for the type species of genus *Cepora;* both names having been proposed in 1775. Examining this case, I find that the International Commission of Zoological Nomenclature in its Opinion No. 516, of 1958, has ruled that the work of Fabricius is to be given priority over that of Cramer. Hence, it can be concluded that *nerissa* has precedence over *coronis*, on the subjective taxonomic ground. This derivation, however, is not in agreement with Peile [1937, A GUIDE TO COLLECTING BUTTERFLIES IN INDIA], which shows *coronis* as valid name.

Similarly, in the case of validity to be accorded to one of the two species names, *calais* Cramer and *amata* Fabricius, for the type species of genus *Colotis*, I consider *amata* as the prior name, on the basis of same ground given for *nerissa* above. In this case, my derivation is not in agreement with Talbot [1939, op. cit.], and Wynter-Blyth, who have shown *calais* as the valid name.

Numerous authors have reported that *Catopsilia crocale* and *C. pomona* interbreed in the nature and are, thus, conspecific [see, Talbot, 1947, op. cit. *2*: 493]. However, the specimens assigned to these names are morphologically well-differentiated and they are neither sexual forms nor seasonal forms of each other. Hence, under the circumstances, I am of the opinion that instead of treating them entirely synonymous, they may be retained as two separate subspecies as *C. crocale crocale* and *C. crocale pomona*, under *C. crocale* (Cramer), which is the prior name among the two. [See Table 5].

TABLE 5

PIERIDAE

	Page No.	For	Correct
		Subfamily Pierinae: Whites	
1.	415	*Aporia leucodyce* (Eversmann)	*Aporia leucodice* (Eversmann)
2.	419	*Delias thysbe* (Cramer)	*Delias acalis* (Godart)
3.	421-422	Genus *Huphina* [Moore] (now *Cepora*)	Genus *Cepora* Billberg
4.	425	Genus *Belenois* [Hübner] (now *Anaphaeis*)	Genus *Anaphaeis* Hübner
5.	„	*Belenois mesentina* (Moore) now *A. aurota* (Fabricius)	*Anaphaeis aurota* (Fabr.)
6.	426	*Appias lalage* (Doubleday)	*Appias pandione* (Geyer)
7.	429	*Appias albina* (Boisduval)	*Appias albina darada* (C. Felder & R. Felder)

	Page No.	For	Correct
8.	431	*Appias nero* (Fabricius)	*Appias nero galba* (Wallace)
9.	434	*Pieris brassicae* (Linnaeus)	*Pieris brassicae nepalensis* Doubleday
10.	435	*Pieris rapae* (Linnaeus)	*Pieris rapae iranica* Le Cerf
11.	,,	*Pieris* (now *Pontia*) *daplidice* (Linnaeus)	*Pontia daplidice moorei* (Röber)
12.	,,	*Pieris* (now *Pontia*) *glauconome* (Klug)	*Pontia glauconome* Klug
13.	436	*Euchloe ausonia* (Hübner)	*Euchloe ausonia daphalis* (Moore)
14.	438	*Colotis amata* (Fabricius) now *C. calais* (Cramer)	*Colotis amata* (Fabr.)
15.	439	*Colotis protractus* (Butler) now *C. phisadia* (Godart)	*Colotis phisadia protractus* (Butler)
16.	442-444	Genus *Parenonia* [Bingham] (now *Valeria*)	Genus *Valeria* Horsfield
17.	444	*Parenonia valeria* (Cramer)	*Valeria valeria anais* (Lesson)
		Subfamily: Coliadinae: Yellows	
18.	446	*Catopsilia pomona* (Fabricius)	*Catopsilia crocale pomona* (Fabr.) stat. n.
19.	447	*Catopsilia florella* (Fabricius)	*Catopsilia pyranthe* (Linn.)—Dry season form *florella* (Fabr.)
20.	448	*Dercas verhueli* Moore	*Dercas verhuelli* (Hoeven)
21.	449	*Gonepteryx aspasia* Ménétries, now *mahaguru* (Gistel)	*Gonepteryx mahaguru mahaguru* (Gistel)
22.	450-454	Genus *Terias* [Swainson] (now *Eurema*)	Genus *Eurema* Hübner
23.	450	*Terias libythea* (Fabr.) now *E. brigitta* (Cramer)	*Eurema brigitta rubella* (Wallace)
24.	453	*Terias blanda* Boisduval	*Eurema blanda silhetana* (Wallace)
25.	455	*Colias croceus* (Fourcroy), now *electo* (Linnaeus)	*Colias electo fieldi* Ménétries

BIRDS SEEN ALONG A MOUNTAIN TRAIL IN PAKISTAN[1]

P. JONES[2]

(*With two text-figures*)

As anyone who has ever walked the Himalaya knows, this vast and complex chain is extraordinarily rich in bird life. One of the true pleasures of the walker or climber is to keep an eye out for, among other facets of nature, the interesting species of birds to be met with as he or she pursues some other quest up river valleys and across mountain passes. I had the great good fortune to make an acquaintance with Himalayan species while a high school student at Landour, Mussoorie, U.P., and on treks in the Nag Tibba area and beyond to Dodi Tal and the ridges above the Hanuman Chatti. More recently, while living in Pakistan, I was able to visit the mountains that surround the northern end of the Himalaya: the Kaghan Ranges, the trans-Indus Kohistan, which incorporates the fabled Valley of Swat, and the upper Bashkar Valley of the Buni Zom Range in South-eastern Chitral.

As these were usually climbing trips, and my duties seemingly always entailed hiring porters, moving equipment, and setting up camps, it was not possible to do any concentrated bird watching. Hence, this list is not intended to be a comprehensive one, but rather an example of the variety of birds that can be seen along an Himalayan trail and the pleasure they can afford the amateur bird watcher.

The specific trail in question here is that which begins at Matiltan (8,000′), the road-head, in the Ushu (ooshoo) Valley of Kalam Tehsil, Swat, from which we departed on June 11, 1975. Our route (see Figure 1), took us up the Ushu and across the Kachakhani Pass (*c.* 15,600) into the Bashkar Gol of Chitral. We then proceeded up the Bashkar Valley, attempted Ghochhar Sar, and returned to upper Swat via the Manali Pass (*c.* 16,100) and the unmapped Gabral Valley. The list below describes the birds seen on this trip, but I have also taken the liberty of adding some notes from previous trips in Swat, as well as some from the Kaghan Valley, where the Chitral group spent a week prior to going to Matiltan. For those interested, I have also appended a list of birds seen at Nathiagali during a three-day stay in April 1975.

It should be noted that wherever possible observation was made with the aid of field glasses. Identification was made with reference to Sálim Ali's INDIAN HILL BIRDS, (Bombay: OUP, 1949), and S. Dillon Ripley's A SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN, (Bombay: BNHS, 1961). The number given for each species below refers to the number of that species in Ripley's SYNOPSIS.

166 **Aquila chrysaetos,** Himalayan Golden Eagle.

On the same day, but at a higher altitude (12,800), as 213, we watched as one of these magnificent birds put up a covey of pheasant (see 305).

[1] Accepted September 1976.

[2] 705 South Main St., Wishington, Pa. 15301, U.S.A.

181 **Gyps himalayensis,** Himalayan Griffon Vulture.

Watched this bird patrolling the Bashkar Gol around Gareek one evening, and saw him again the next morning as we walked up to the lake—June 27 and 28, 1975.

213 **Falco subbuteo,** Central Asian Hobby.

Observed in June 1974 on the ridges east above the Mahodand Meadows, at about 11,500. In March 1975, I saw this species at about 7,500 near the village of Nakkai Imam Chatti on the lower slopes of Musa ka Musela and in June 1975 on the upper ridges of the same mountain (about 12,000) in the Kaghan Valley.

236 **Alectoris graeca,** Chukor Partridge.

Heard and observed in the early morning at the Willow Camp in an area of meadow

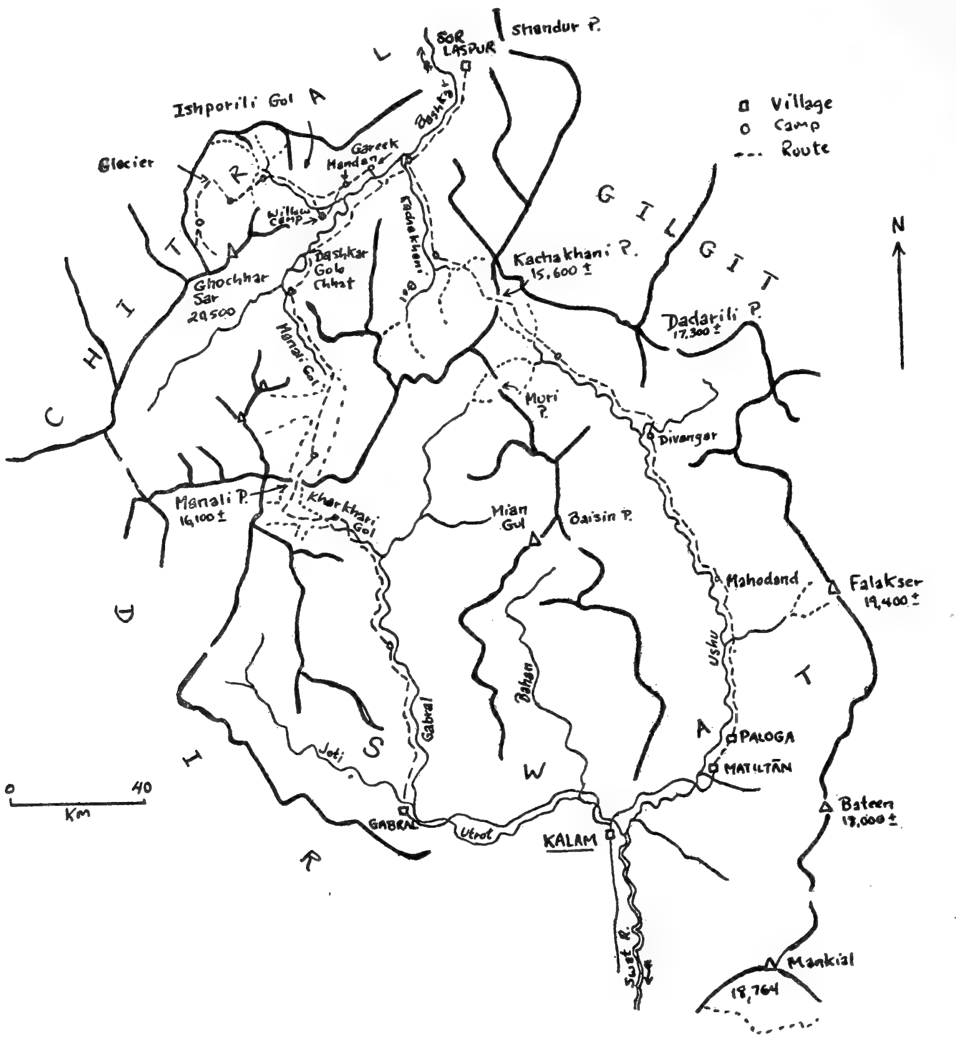


Fig. 1. Sketch map of Author's route to Chitral.

interspersed with large boulders.

305 **Pucrasia macrolopha,** Koklas Pheasant.

A covey of five birds was put up by a Golden Eagle at about 12,800′ on the meadows to the east high above Mahodand. What was memorable about this event was the opportunity to see how the covey seemed to send out a decoy when frightened by the eagle. We were resting on a small alp when the eagle appeared. The main body of pheasant flew low to the ground down the ridge, while one bird detatched itself, flew out behind our alp and rejoined the covey behind a screening ridge. The eagle made no predatory move. See diagram below (Fig. 2).

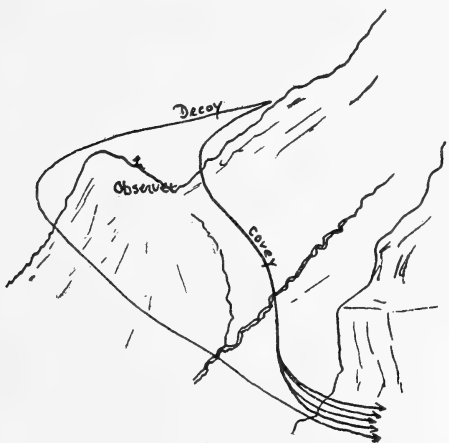


Fig. 2

513 **Columba leuconota,** Snow Pigeon.

Saw a pair just above the confluence of the Kharkhari Gol with the Gabral River. Though familiar with the bird from the excellent colour plate in Ali's HILL BIRDS, this was my first actual sighting of this species. I was surprised at how large a bird it was. One of the pair made several slow, wide sallies over the valley before returning to perch on a large boulder. The effect of the flight as well as the predominant whiteness of the bird while in flight almost reminded one of gulls at the seashore. Identification through glasses was unmistakeable. Was thrilled to see this species.

515 **Columba rupestris (turkestanica),** Turkestan Rock Pigeon.

Also a first sighting. This occurred in the Ishporili Gol, at the terminus of the Ishporili Glacier moraine (*c.* 13,800). The birds were brought to my attention by one of our Chitrali porters, who was also a shikari. He had earlier used the glasses to spot a large herd of markhor. Without his aid, I would not have seen these birds, as they were extremely well-camouflaged against high cliffs.

580 **Cuculus saturatus,** Himalayan Cuckoo.

We heard this bird almost every evening while in the Bashkar Gol below the lake, especially around Mandan and the Willow Camp, where this species was finally spotted in a grove of stunted birch—June 26, 1975.

694 **Apus melba,** Alpine Swift.

As in 913 below. A large swift. The evening swarms above the Bashkar Lake seemed tireless.

913 **Hirundo rupestris,** Crag Martin.

Noted all through the Bashkar, Kachakhani, Ishporili and Manali Gols, in company with the Alpine Swifts and House Martins. The birds were very active over the rivers and especially over the Bashkar Lake in the mornings and evenings. At the latter place, there were hundreds of birds—in clouds it seemed—dashing all over the sky above the lake with their incredibly swift and intricate aerial dynamics. With the swifts and other martins, they appear to nest in the vast cliffs above the lake.

916 **Hirundo rustica,** Common Swallow.

Very common in the lower Swat valley in the towns both above and below Mingora. Hundreds swarm in the streets down to a foot

or two above the ground amongst crowds and traffic—incredibly, without colliding with anything or anyone. A familiar sight in early July are the long lines of swallows on telephone wires.

931 **Delichon urbica,** House Martin.

As 913.

1022 **Garrulus lanceolatus,** Blackthroated Jay.

Seen at Bela Village (6,300), above Paras, Kaghan Valley, March 27, 1975.

1029 **Pica pica (bactriana),** Kashmir or Whiterumped Magpie.

In and around Sor Laspur and once at Mandan, I noticed a Magpie-like bird with a prominent tail, black and white colouring, and a conspicuous white patch on the wing. He seemed fond of the Poplar groves around the fields of Laspur. This was an entirely new species for me, so I made sketches and later identified the species with the aid of Mr. J. Bruce Amstutz.

1045 **Pyrrhocorax graculus,** Yellowbilled Chough.

We spotted this bird at about 11,000 on Makra above the FRH at Shongran in the Kaghan Valley on June 4, 1975. In the Ushu Valley, the bird first begins to appear at the place where the Falakser Dhand (torrent) meets the Ushu about 11 miles beyond Matiltan. From that point (ca. 10,000) we noted it at least once a day to the Kachakhani Pass. It was common in the areas of Chitral which we visited, especially around the great cliffs above the Willow Camp (11,500) where there were numerous nesting pairs. The species seems most gregarious. One evening I watched a flock of perhaps sixty to eighty birds feeding together in open grassy terrain in the moraine hills above the Willow Camp. The highest we saw this bird in Chitral was at about 18,000′ above the Ishporili Glacier—the same height at which I saw a small flock of this species on Mankial (Swat) in August 1974. This Chough was also common in the Manali and Kharkhari Gols. Strangely, although I looked for but did not see *P. pyrrhocorax*.

1053 **Corvus monedula,** Jackdaw.

Fairly common around the Rest House, Balakot, Kaghan Valley (Hazara) in March 1975.

1059 **Corvus corax,** Raven.

Noted a pair at the Mahodand Meadows (*c.* 10,500), Ushu Valley, Swat on June 6 and 7, 1974. They kept to a dense stand of pines at the north end of the meadows and at first seemed agitated at our arrival. Their raucous, duck-like call is unforgettable.

1085 **Pericrocotus ethologus,** Longtailed Minivet.

Noted several breeding pairs at Shongran FRH, Kaghan Valley in early June 1975. Keeps very much to stands of pine.

1125 **Pycnonotus leucogenys,** Whitecheeked Bulbul.

At Balakot (3,300) and Paras (4,300), in the Kaghan Valley, March 27, 1975.

1289 **Garrulax variegatum,** Variegated Laughing Thrush.

First met with this species while on a morning walk up the torrent above Kalam, Swat, at about 8,000, in an open fir and deciduous forest with an undergrowth of Redbud and May Apple. Saw this bird several times and heard its remarkable song, which seems to be preceded by a low hum. I came close enough to one to frighten it from its nest, which, finally found, was a well-made cup of grass and pine needles placed about 4 inches off the ground in a verdant patch of flowers and small shrubs. The nest contained no eggs. This occurred on June 11, 1974. On June 13, 1975 at Divangar (lit. Diwan-ghar) in the

Ushu Valley, we heard this species several times. It was observed once in the extensive undergrowth by the pond at the Willow Camp in the Ishporili Gol (11,500). We also heard another thrush, but did not see it: could it have been the Plain-Backed Mountain Thrush?

1313 **Garrulax lineatus,** Streaked Laughing Thrush.

Noted a thrush song around Sor Laspur (9,700′)—our lowest altitude in Chitral—and saw several birds there in willow and poplar thickets. It is a small thrush, gregarious and most active in flocks on the ground.

1396 **Heterophasia capistrata,** Blackheaded Sibia.

Saw one bird in a grove below Madyan (*c.* 4,000), middle Swat, July 4, 1975. This area is somewhat west of Ali's distribution range for this species.

1579 **Phylloscopus affinis,** Tickell's Leaf Warbler.

Fairly common in early June 1974 at the Mahodand Meadows (10,500), Ushu Valley, Swat.

1650 **Erithacus brunneus,** Blue Chat.

Believe I spotted a pair (M and F) by the Kunhar River at Balakot (3,300′), Kaghan Valley, March 30, 1975. Noted, June 3 and 4, 1975, along the meadows at Shongran FRH and in the thickets along the road from Sarai (9,000) towards Makra Peak.

1654 **Erithacus cyanurus,** Orangeflanked Bush Robin.

Found this species to be quite common—noted at Sor Laspur (9,700), the Kachakhani Gol (10,200), at Mandan (11,500), in the Ishporili Gol (up to 14,000), and at and above the Bashkar Golo Chhat, both male and female. It seems to enjoy clumps of stunted birch and willow, though it is also common along streams with a sparse covering of undergrowth over rocky terrain. Its colours are not so brilliant as those of Plate 26 in Ali's HILL BIRDS. We called this the "paper-tearing bird," because its song is always followed by an abrasive sound, as if paper is being torn.

1675 **Phoenicurus frontalis,** Bluefronted Redstart.

Noted only once during the trip—on a small tributary of the Bashkar just below the Bashkar Golo Chhat (lake) at 11,900′.

1679 **Rhyacornis fuliginosus,** Plumbeous Redstart.

As above, common in the Kaghan and Swat Valleys. We did not see this species in Chitral, but began to see it again in the Gabral Valley.

1680 **Hodgsonius phoenicuroides,** Hodgson's Shortwing.

Commonly seen in the Bashkar Valley of Chitral, from 10,000 to 14,000 feet. It seemed to be always present, especially favouring rocky ground with patchy ground cover. In the Ishporili, it was to be found in places that were still covered with winter snow—though it was melting rapidly.

1688 **Enicurus maculatus,** Spotted Forktail.

Noted at Bahrein (6,000′), middle Swat, August 23, 1973. This was the only time I saw this bird in this part of the sub-continent. It seems to be considerably less common here than in Tehri-Garhwal, India.

1697 **Saxicola torquata,** Collared Bushchat.

Noted at about 7,500 on the road from Bela Village to the Sharan FRH, Kaghan Valley. In March 1975, I had noted this species at Paras, beside the Kunhar River. It seems to have moved up some three thousand feet and is probably nesting in the scrub forest along Sharan Road and around the terraced fields.

1700 **Saxicola caprata,** Pied Bush Chat.

A familiar bird in the sparse growth along the Kunhar below Balakot. Also, commonly seen during the cold season north of the Salt Range.

1705 **Saxicola ferrea,** Dark Grey Bush-chat.

Spotted in the Gabral Valley, at about 9,000′, Upper Swat, July 3, 1975.

1716 **Chaimarrornis leucocephalus,** White-capped Redstart.

This species is to be seen frequently along the Kunhar, Swat, Ushu and Gabral Rivers. It was seen only once in Chitral—at Sor Laspur, but here its colouring was rather washed-out as compared to the bird in upper Swat. Otherwise, we did not see this bird in Chitral, quite possibly because we remained at too high altitudes while in Chitral. However, once across the Manali An (Pass) and into the Kharkhari Gol, we began to see it once again.

1726 **Monticola solitarius,** Blue Rock Thrush.

Spotted at Gareek (*c.* 10,800′). Bashkar Valley. It remained atop a huge boulder for some minutes while I observed through glasses.

1729 **Myiophoneus caeruleus,** Himalayan Whistling Thrush.

A much loved bird—noted several times in the Ushu Valley, Swat, but never above 10,500 feet. Not seen in Chitral at all, but we did see it several times again in the Kharkhari Gol, where the torrent and grass-covered cliffs made for an ideal nesting site. In this area it seems a silent and subdued bird—a little disappointing for one who knows the Mussoorie area well.

1773 **Cinclus cinclus,** Kashmir Dipper.

First saw this species in June 1974 along the sand banks of the Ushu at the Mahodand Meadows. In June 1975, met this bird twice in the Upper Ushu—once at Divangar and once at a point about two miles above Divangar where the river broadens out and flows quite calmly for several hundred yards. At the latter place, where the bird was seen at mid-morning, the Kashmir Dipper was wading along sand shoals and taking short, restless flights up and down the river. At Divangar, the previous evening, I watched a Dipper for quite some time, noted its bobbing and curtseying manner and saw it disappear into very swift water several times in search of food: a most lively display. Divangar is at an altitude of about 11,500′.

1775 **Cinclus pallasii,** Brown Dipper.

Believe I spotted this bird along the Ushu River about a mile and a half below Divangar, where we had halted for lunch. It seemed to be in a great hurry and was kept under observation for only a few moments.

1782 **Prunella strophiata,** Rufousbreasted Hedgesparrow or Accentor.

Fairly common in the extensive meadows at Gareek and around Willow Camp. Also noted in the Ishporili and Bashkar Gols, in the latter place, especially around the lake.

1792 **Parus major,** Grey Tit.

At the Nadi FRH (locally known as the Kund Bungalow), at 7,800 above Balakot, Kaghan Valley on April 29, 1974. This species seems far less common in Hazara and Swat, as compared to the Mussoorie area in U.P., India.

1802 **Parus melanolophus,** Crested Black Tit.

Also noted at the Mahodand Meadows, Ushu Valley and in the Gabral Valley, both in Swat, June 1975.

1804 **Parus rubidiventris,** Rufousbellied Crested Tit.

Common in the evergreen stands around the Mahodand Meadows in June 1974 and

1975. The species is most active during the early mornings and late evenings and has a most attractive double whistle.

1807 **Parus dichrous,** Brown Crested Tit.

Sighting uncertain. I thought I saw this species in the great forest behind Sharan FRH in the Kaghan Valley at about 9,000′. But, having discussed this possibility with Mr. Tom Roberts of Karachi, I must bow to his vast experience and record this sighting as unlikely.

1855 **Anthus trivialis,** Tree Pipit.

Found in the groves around Sor Laspur.

1883 **Motacilla citreola,** Yellowheaded Wagtail.

One of the commoner birds on the trip. Noticed often in the upper Ushu Valley. Except for the Chough, this was the last bird we saw before ascending the Kachakhani Pass. It was at the very last portion of open water on the Ushu (*c.* 13,900). It was also present in the Bashkar Gol. A breeding pair was noted around the large pond at the Willow Camp. The male in breeding plumage is a brilliant yellow, and this and the antics of the fellow at Willow Camp on more than one occasion brought out our party's telephoto lenses.

1886 **Motacilla alba (personata),** Masked Wagtail.

Was quite surprised at meeting with this species. Observed at a small pond in the meadows which cover the moraine hills just above and between the confluence of the Ishporili with the Bashkar Gol.

1887 **Motacilla alba,** Hodgson's Pied Wagtail.

Observed at Gareek (10,800), Bashkar Valley.

1946 **Passer rutilans,** Cinnamon Tree Sparrow.

Several nesting pairs around the FRH, Shongran, Kaghan.

1982 **Mycerobas icterioides,** Black-and-Yellow Grosbeak.

Noted once in a forested area, Gabral Valley, Swat, at about 8,000.

1989 **Carduelis carduelis (caniceps),** Himalayan Goldfinch.

Noted a small flock of about two miles above Sor Laspur at about 10,000 feet. This was at the first stand of poplar and willow that one comes to upon walking down the valley.

1990 **Carduelis spinoides,** Himalayan Greenfinch.

First noted at Bara (8,000) in the Chukail Valley, Swat in August 1974. On the Chitral trip, we saw this species at Gareek (10,800), Bashkar Gol.

2010 **Carpodacus erythrinus,** Rosefinch.

Enjoyed watching this species very much. Active and busy—spotted several times at Mandan (11,500), both male and female, in pairs or flocks of four or more. Also noted at the Bashkar Golo Chhat (12,000). The male is distinctly rose-coloured around the head, nape and throat, but elsewhere this fades into a light brown colour, just perceptibly tinged with pink.

2051 **Emberiza cia,** Meadow Bunting.

Common in the Ushu, Gabral and Bashkar Valleys.

BIRD LIST, NATHIAGALI, PAKISTAN, APRIL 27-30, 1975.

580 **Cuculus saturatus,** Himalayan Cuckoo.

Nathiagali.

662 **Strix aluco,** Himalayan Wood Owl.

On Miran Jani at about 9,000.

807 **Picus squamatus,** Scalybellied Green Woodpecker.

Common at Nathiagali.

836 **Picoides himalayensis,** Himalayan Pied Woodpecker.

Nathiagali.

842 **Picoides auriceps,** Brownfronted Pied Woodpecker.

Nathiagali.

1042 **Nucifraga caryocatactes,** Largespotted Nutcracker.

Nathiagali, 8,100.

1148 **Hypsipetes madagascariensis,** Black Bulbul.

Nathiagali.

1181 **Pomatorhinus erythrogenys,** Rustycheeked Scimitar Babbler.

Nathiagali.

1341 **Pteruthius flaviscapis,** Redwinged Shrike-babbler.

Nathiagali.

1342 **Pteruthius xanthochloris,** Green Shrike-babbler.

Tentative sighting, Nathiagali.

1396 **Heterophasia capistrata,** Blackheaded Sibia.

Nathiagali.

1421 **Muscicapa superciliaris,** White-browed Blue Flycatcher.

Common at Nathiagali.

1445 **Muscicapa thalassina,** Verditer Flycatcher.

Nathiagali.

1606 **Phylloscopus occipitalis,** Large Crowned Willow Warbler.

Nathiagali.

1705 **Saxicola ferrea,** Dark-grey Bush Chat.

Common at Nathiagali, also frequently seen on Miran Jani at 9,100.

1723 **Monticola cinclorhynchus,** Blueheaded Rock Thrush.

Several times at Nathiagali.

1824 **Sitta europaea,** Kashmir Nuthatch. Miran Jani, 9,000.

1832 **Sitta leucopsis,** Whitecheeked Nuthatch.

Nathiagali.

1845 **Certhia himalayana,** Himalayan Tree Creeper.

Nathiagali.

1946 **Passer rutilans,** Cinnamon Tree Sparrow.

Common at Nathiagali.

1982 **Mycerobas icterioides,** Black-and-Yellow Grosbeak.

Common at Nathiagali.

1983 **Mycerobas affinis,** Allied Grosbeak Nathiagali.

THE GENUS *ATHYRIUM* ROTH IN NAINITAL HILLS[1]

K. K. Dhir[2] and K. Rani

(*With ten text-figures*)

The paper deals with an illustrated taxonomic account of ten species of the genus *Athyrium* Roth from Nainital hills (North-Western Himalayas). From the detailed morphological observations, it is concluded that caudex coupled with indusial and spore ornamentation are found to be constant and decisive characters to classify the species. Half the number of species have distinctly perisporiate spores whereas the other half falls into the category of having non-perisporiate spores.

The Himalayan species of *Athyrium* Roth, the type genus of family Athyriaceae, have been variously treated by earlier workers. Clarke (1880) and Hope (1899, 1903) considered *Athyrium* as a subgenus of *Asplenium* Linn. Beddome (1883) kept *Athyrium* separate from *Asplenium* but he could not properly analyse the species complexes and their nomenclature. Bir & Shukla (1966) described 16 members of this rather difficult genus from Simla hills. Recently Dhir & Datta (1976) gave an explicit taxonomic account of *Athyrium* Roth from Dharamsala hills. In the present paper. which is a part of the project on 'Taxonomic revision of Himalayan Ferns', 10 members of the genus from Nainital hills are described and illustrated alongwith the key for identification in the field. Voucher specimens are deposited in PAN.

Athyrium Roth

Rhizome short, erect or decumbent or elongate-creeping, scaly; Rachis glabrascent or sparsely scaly, grooved; lamina pinnately decompound, sometimes simply pinnate; texture herbaceous to coriaceous, glabrous except on the axes; venation anadromous, veins always free; sori dorsal, typically elongate, sometimes short and roundish; indusium of the same shape with entire or lacerate-fimbriate margins.

A large genus comprised of nearly 200 species with world wide distribution. 10 species occur in the area investigated.

Key to the species

A. fronds pinnate.
- B. Rhizome ascending; fronds caespitose; lamina small to medium sized.
  - C. Rhizome scales dull-brown in colour.
    - D. Lamina lanceolate, not attenuated downwards; spores perisporiate.
      - E. Stipe brown, thin and fragile; sporangium non-glandular; indusium with acutely lobed margin ......*A. anisopterum*
      - E. Stipe straw coloured, firm and erect; sporangium stalk with a gland; indusium with a wavy margin ......*A. rupicola*

[1] Accepted May 1978.

[2] Department of Botany, Panjab University, Chandigarh.

D. Lamina linear-lanceolate, attenuated downwards; spores non-perisporiate ......*A. attenuatum*

C. Rhizome scales golden or bright brown in colour

D. Lamina linear-lanceolate, narrowed at both ends, hairy; indusium lacerate ......*A. falcatum*

D. Lamina oblong-lanceolate, never attenuated at base, glabrous; indusium small, fugaceous ......*A. drepanopterum*

B. Rhizome wide-creeping; fronds distant; lamina large, broadly-lanceolate; rachis and rachilets covered with multicellular uniseriate hairs; indusium with wavy margin; spores tuberculated ......*A. japonicum*

A. Fronds bipinnate to decompoundly-pinnate.

B. Rhizome ascending; fronds approximate, spores non-perisporiate.

C. Costae and costules setiferous; lamina broadly lanceolate, rooting by vegetative buds ......*A. clarkei*

C. Costae and costules not setiferous; lamina lanceolate, acuminate; stipe dark brown at base ......*A. proliferum*

B. Rhizome wide-creeping; oblong lanceolate to sub-deltoid lamina; spores perisporiate

C. Fronds bipinnate; stipe dark brown at base; secondary rachis glabrous; indusium with irregularly lobed margin ......*A. schimperi*

C. Fronds 3-4 pinnate; stipe stramineous, secondary rachis pubescent and spiny; sori minute; indusium with a wavy margin ......*A. pectinatum*

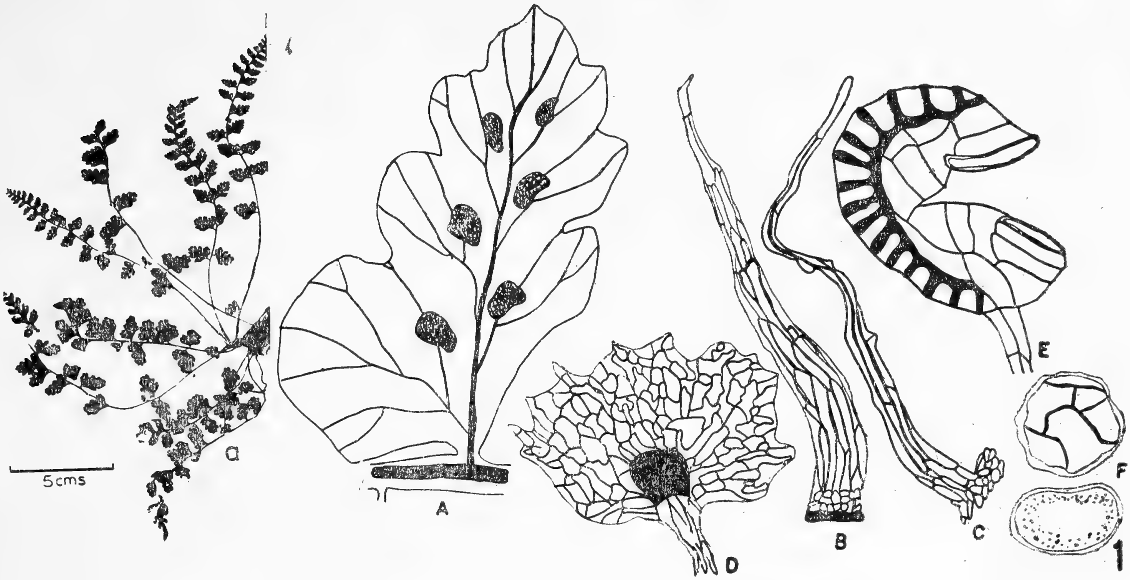
A. anisopterum Christ, Bull. Herb. Boiss. 6, 962, 1898.

Rhizome 0.5-0.7 cm thick, ascending, thickly covered at the apex with brown, lanceolate, 6.5-7 mm long, 0.6-1 mm broad at base scales; fronds closely tufted; stipes upto 6-7 cm long, fragile, brown, scaly at base, scales filiform, about 2 mm long and 0.2-0.3 mm broad at base with almost entire margin; lamina 10-14 × 1.5-2.5 cm, lanceolate, membranaceous, bipinnatifid; pinnae upto 13-14 jugate, broadly lanceolate, shortly stalked, cut down 1/3 to 2/3 distance to mid rib into distinct segments with crenate margin, basal lobe enlarged forming an auricle on the anterior side; texture rather flaccid, pinnatifid; venation pinnate, each vein 1-2 times forked; sori curved, generally on superior veinlets, indusiate; indusium stalked, reniform, membranaceous with acutely lobed margin; sporangia with 14-15 annulus cells; spores dark brown, globose, perisporiate (Fig. 1).

It grows on shaded and humus rich rocks in the dense forests near Kilberi and Pangote (1,500-2,000 m). Very common in the area investigated.

A. rupicola (Hope) C. Chr., Ind. Fil., 145, 1905.

Rhizome upto 0.3-1 cm thick, ascending, covered with a tuft of scales; scales 6-7 mm long, 1-1.5 mm broad at base, dull brown, linear lanceolate, hair pointed and uniseriate; fronds tufted, 24-36 cm, dull green; stipes 7-12 cm long, firm, erect, straw coloured, clothed near the base with similar to rhizome but deciduous scales; lamina 17-24 × 6-9 cm, lanceolate, bipinnatifid; pinnae 18-25 jugate except for the acuminate apex, alternate, subsessile, 3-4.5 cm × 0.8-1.2 cm, narrow, lanceolate, acuminate at apex, cut down into 6-14 pairs of 4-5 mm × 1-3 mm pinnules with crenate or serrate margin, lower 1-2 pair deflexed; texture sub-coriaceous; veins pinnate, generally forked, one veinlet to each tooth, rachilets wavy; sori median, generally along the superior veinlets, linear or globose, indu-



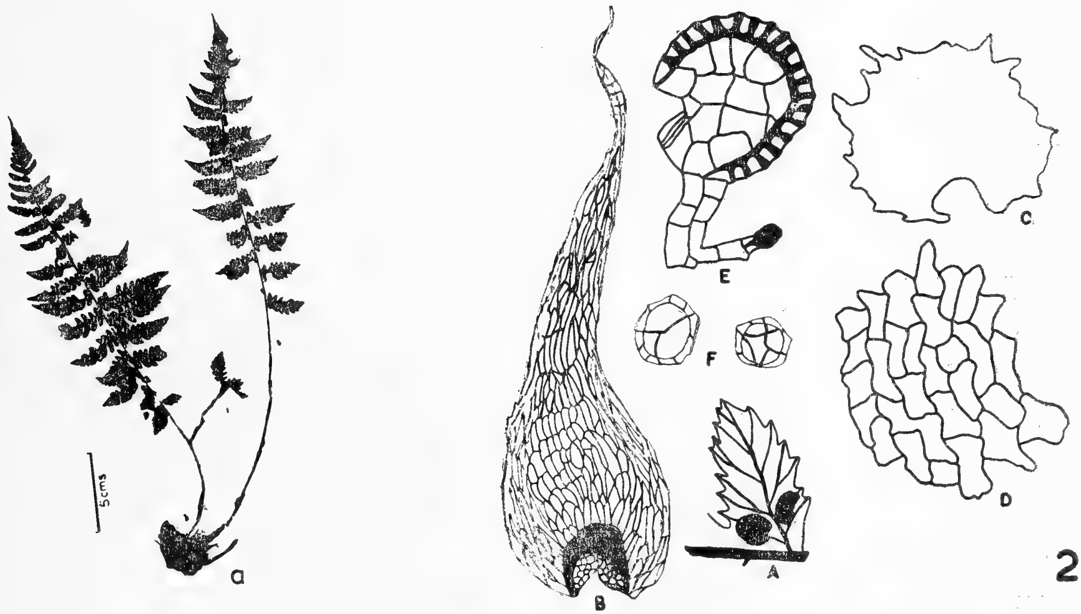


Fig. 1. *Athyrium anisopterum*. a. Plant. A. Pinna showing venation, × 4.6; B. Rhizome scale, × 21.8; C. Stipe scale, × 21.8; D. Indusium, × 21.8; E. Sporangium, × 97.9; F. Spores, × 282.8.

Fig. 2. *Athyrium rupicola*. a. Plant. A. Pinna showing venation, × 3.8; B. Rhizome scale, × 8.4; C. Indusium, × 17.8; D. Indusial cells, × 74.2; E. Sporangium, × 74.2; F. Spores, × 231.7.

siate; indusium thin, membranaceous, globose, margin wavy with a few projections; sporangia with 19 celled annulus, glandular, glands stalked and attached near the base of the sporangial stalk; spores perisporiate with broad folded perisporium (Fig. 2).

It is always found growing in exposed places. Enroute Cheena Peak (2,600 m).

A. attenuatum (Clarke) Tagawa, Acta Phytotax. et Geobot., 16, 177, 1956.

Rhizome 1-1.5 cm thick, erect, densely covered with scales; scales brown, lanceolate, subulate, 5-6 mm long, about 1 mm broad at base; fronds 30-35 cm long, closely caespitose; stipes 2-6 cm long, firm, erect, grooved, scaly below; scales 3-5 mm long, similar to rhizome scales, lamina 25-32 × 3.5-7.4 cm, linear-lanceolate, bipinnatifid; pinnae 25-29 pairs, patent or slightly ascending, pinnae gradually reduced, cut down into small closely placed segments with serrate margin; texture herbaceous, greenish-brown; venation simple or once forked; mid vein wavy; sori small acroscopic, indusiate; indusium reniform with irregular projections along the margin; sporangia with 16-17 annulus cells; spores light-yellow in colour, non-perisporiate, bilateral with smooth exine (Fig. 3).

Met with near Land's end as a lithophyte in rock-crevices.

A. falcatum Bedd., Ferns South India, t. 151, 1863.

Rhizome 2-6 mm thick, short, ascending, profusely branched, scaly; scales linear-lanceolate with long drawn out apical part, wavy margined, 8-9 mm long and 0.5-0.8 mm broad at base; fronds rather approximate; stipes 2.5-6 cm long, firm, erect with a well developed basal part, scaly; scales golden, linear-lanceolate, hair pointed uniseriate, margin smooth, 8-9 mm long and 0.5-0.9 mm broad at base; lamina 10.5-35 × 2.5-5 cm, linear-lanceolate, narrowed at both ends, bipinnatifid, primary rachis covered with similar to rhizome but smaller scales; pinnae 20-28 jugate, alternate, subsessile, lowest 2-3 pairs deflexed; pinnae falcate, generally furnished with a large obtuse auricle at both the superior and inferior base, cut down into 8-10 pairs of 1-3.2 × 4-8 cm pinnules with crenated margin and obtuse apex; texture herbaceous, hairy along the veinlets, hairs 3-4 celled, thin walled; venation simple or sometimes forked; sori linear along the veinlets opening towards the mid-rib, indusiate; indusium more long than broad having finger-like lacerae along the margin; sporangia with 15-celled annulus; spores non-perisporiate, tuberculate (Fig. 4).

Grows on moist, exposed rocks. Commonly met with near Bhowali (1,500 m) and Sat-tal (1,200 m).

A. drepanopterum (Kze.) A. Br., Milde, Fil. Eur. 49, 1867.

Caudex stout, 3-5 cm in diameter, ascending, clothed with numerous reddish-brown, linear-lanceolate, hair uniseriate pointed, smooth margined having clear luminae with a few distorted cells, 6.7-10 mm long and 0.7-1 mm broad at base scales; fronds caespitose; stipe 8-15 cm long, grooved, dull straw-coloured, scaly at base, scales persistant, similar to rhizome scales; lamina 18-22 × 2-4 cm, oblong-lanceolate, 1-2 pinnate; pinnae 28-32 jugate, often falcate, subsessile, alternate, 2-3 cm × 4-6 mm, deeply pinnatifid into 8-11 segments; pinnules 2-3 × 1-2 mm, ovate-lanceolate, auricled with serrate margin; texture coriaceous; venation simple, veins pinnated, almost reaching the margin; sori small, linear or curved in two rows one on either side of the mid rib, median, indusiate; indusium often hippocrepiform, brown, fugacious, membranaceous; sporangia with 14-15 celled annulus,

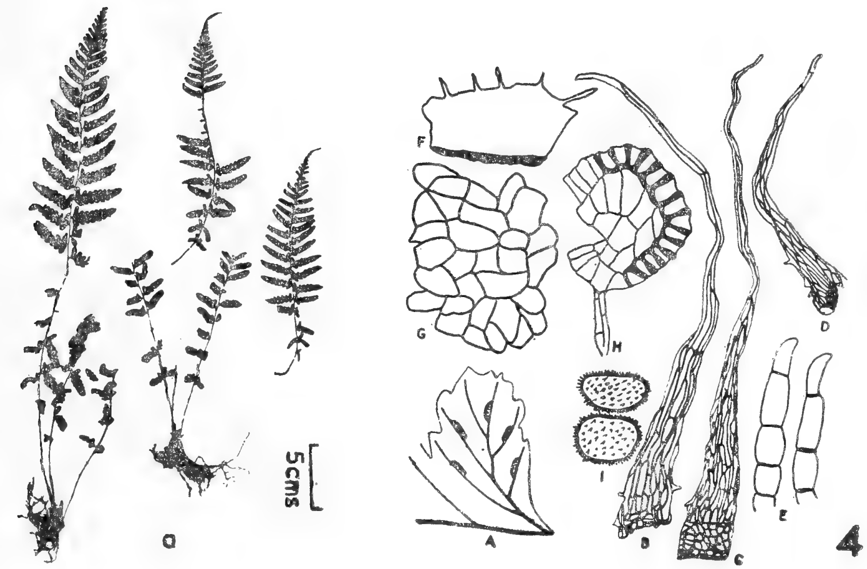
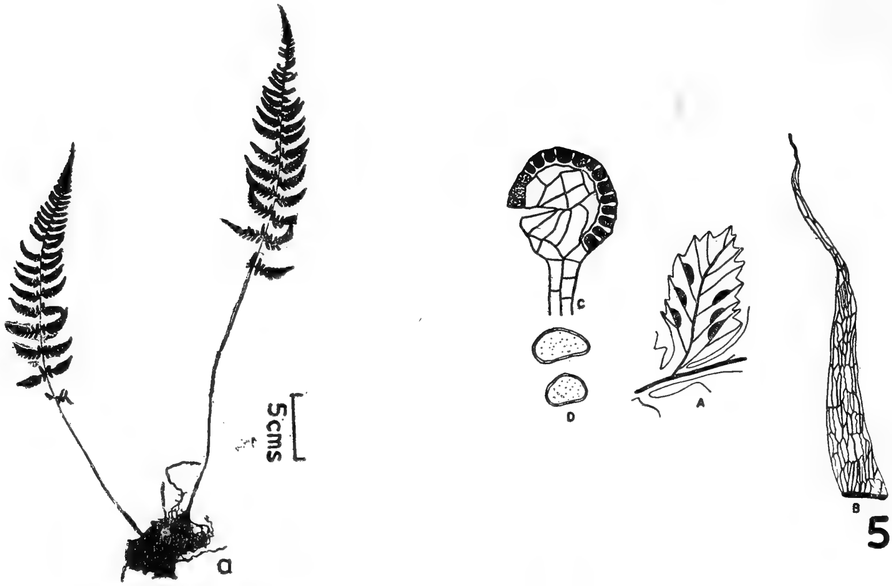


Fig. 3. *Athyrium attenuatum*. a. Plant. A. Pinna showing venation, $\times 2.0$; B. Pinna showing position of sori, $\times 2.0$; C. Rhizome scale, $\times 9.9$; D. Stipe scale, $\times 9.9$; E. Indusium, $\times 28.6$; F. Sporangium, $\times 44.7$; G. Spores, $\times 129.2$.

Fig. 4. *Athyrium falcatum*. a. Plant. A. Pinna showing venation, $\times 2.7$; B. Rhizome scale, $\times 7.2$; C. Stipe scale, $\times 7.2$; D. Rachis scale, $\times 7.2$; E. Hairs on pinnae, $\times 58.08$; F. Indusium, $\times 12.9$; G. Indusial cells, $\times 58.0$; H. Sporangia, $\times 58.0$; I. Spores, $\times 167.8$.



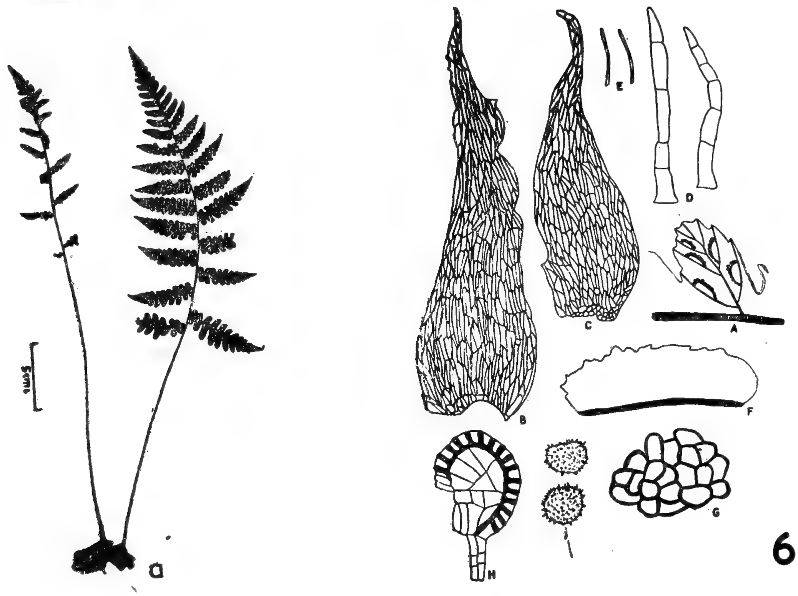


Fig. 5. *Athyrium drepanopterum*. a. Plant. A. Pinna showing venation, × 2.6; B. Rhizome or base of stipe scale, × 7.1; C. Sporangium, × 54.5; D. Spores, × 157.56. Fig. 6. *Athyrium japonicum*. a. Plant. A. Pinna showing venation, × 2.2; B. Rhizome scale, × 10.5; C. Stipe scale, × 10.5; D. Hairs of rachis and rachilets, × 47.6; E. Hairs on surface, × 47.6; F. Indusium, × 10.5; G. Indusial cells, × 47.6; H. Sporangium, × 47.6; I. Spores, × 137.6.

annular cells with thick transparent walls having dark brown luminae; spores hyaline, bilateral with smooth walled exine, non-perisporiate (Fig. 5).

This is a fern of low altitudes (1,200-1,500 m) growing on forest floor along water channels.

A. japonicum (Thunb.) Copel., Phil. Jour. Soc. Bot. 3C, 290, 1908.

Rhizome upto 3-4 mm thick, widely-creeping, scaly; scales 4-6 mm long, 1-2 mm wide at base, pale-brown, thin, lanceolate, hair pointed, sub-entire margined; fronds quite apart, long, herbaceous; stipe 10-20 cm long, scaly, scales similar to rhizome scales but smaller in size; lamina 10-24 × 6-14 cm, broadly lanceolate, bipinnatifid, rachis and rachilets more or less woolly with multicellular uniseriate hairs; pinnae alternate, 2-8 × 0.7-1.5 cm, subsessile, cut down quite to the mid rib into broad, falcate segments with obtuse apex and crenated margin; texture herbaceous, bright green in colour; venation pinnate, veins rarely forked; sori elongated nearer the midrib in 2 rows one on each side of the midrib, indusiate; indusium broad, thin, elongated, membranaceous with wavy margin, indusial cells polygonal with regular cell walls; spores light yellow to brown in colour with tuberculated exine (Fig. 6).

It prefers moist and shaded forest floor. Found at 1,950 m altitude around Nainital.

A. clarkei Bedd., Ferns Brit. India, Suppl., II, t. 360, 1876.

Rhizome 1 mm thick, ascending, scaly at apex; scales 6-8 mm long, 0.5-1.5 mm broad at base, dark-brown, linear-lanceolate, hair pointed uniseriate with smooth margin; fronds caespitose; stipes 11-20 cm long, scaly below, scales similar to rhizome scales but smaller in size; lamina 20-50 × 10-20 cm, lanceolate, bipinnate, rooting from a bud on the upper part of the rachis; pinnae deltoid-lanceolate, upto 9 × 2.2 cm; pinnules shortly stalked, acroscopic, basal one the largest, oblong, lobed up to half the way to the mid rib with serrated apex, primary rachis stramineous, secondary winged, setae present on upper surface along costae and constules; texture herbaceous, green; venation forked 1-2 times, single veinlet supplying to each tooth; sori short, oblong, curved, two rows one to each side of mid rib, indusiate; indusium reniform, thin, fugaceous with almost, wavy margin, indusial cells with smooth walls; sporangia having 14-15 annulus cells; spores light-yellowish-brown, reniform, non-perisporiate with a smooth exine (Fig. 7).

The species was found growing near Kilberi (2,000 m) on humus rich, densely shaded, and moist forest floor.

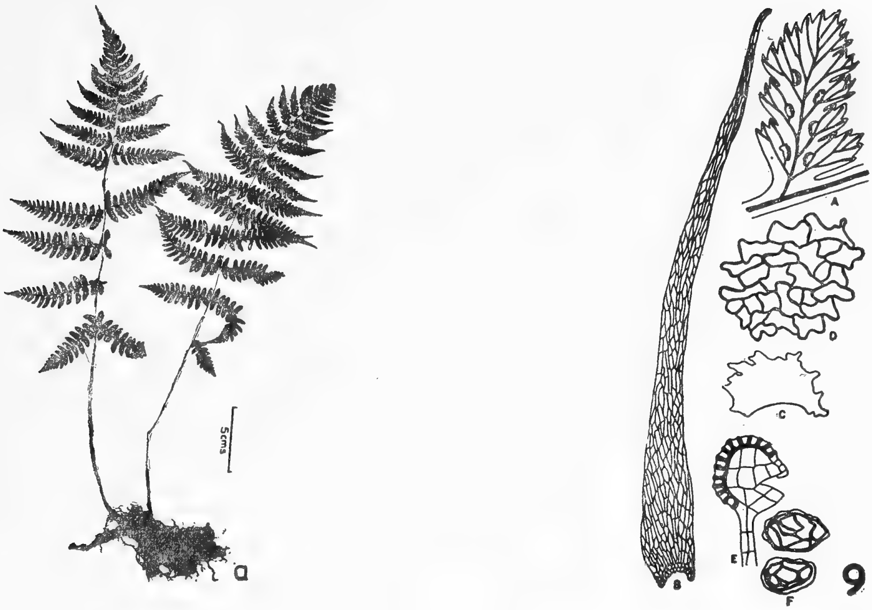
A. proliferum Moore, Gard. Chr., 778, 1866.

Rhizome 1-1.5 cm thick, ascending, scaly; scales 2-2.5 mm long, about 1 mm broad at base, lanceolate to oblong-lanceolate, hair pointed uniseriate, sub-entire margined; fronds closely tufted; stipe 14-17 cm long, hard, grooved, straw coloured with a dark-brown base, scaly, scales 4.5-5 mm long, about 1 mm broad at base, oblonge-lanceolate, hair pointed; lamina 40-44 × 14-16 cm, lanceolate with pointed acuminate apex, tripinnatifid; pinnae 7-9 × 1.8-2.5 cm, lanceolate, 25-28 jugate, cut into 10-14 pairs of pinnules; each pinnule oblong, cut into 4-5 pairs of bifid lobes; texture coriaceous; venation simple, veins forked, almost reaching the margin, mid-vein wavy; sori linear, present along the superior veinlet, indusiate; indusium oblong with wavy margin, indusial cells squarish, irregularly margined with smooth cell walls; sporangia with 13-14 annulus cells; spores bilateral, thin-walled, hyaline, non-perisporiate (Fig. 8).

It prefers humus rich shaded forest floor

Fig. 7. *Athyrium clarkei*. a. Plant. A. Pinna showing venation, × 2.5; B. Rhizome or stipe scale, × 18.0; C. Indusium, × 18.0; D. Indusial cells, × 54.0; E. Sporangium, × 54.0; F. Spores, × 156.0.

Fig. 8. *Athyrium proliferum*. a. Plant. A. Pinna showing venation, × 4.0; B, C. Rhizome scales, × 19.0; D. Stipe scale, × 11.2; E. Indusium, × 19.0; F. Indusial cells, × 248.0; G. Sporangium, × 85.8; H. Spores, × 248.0.



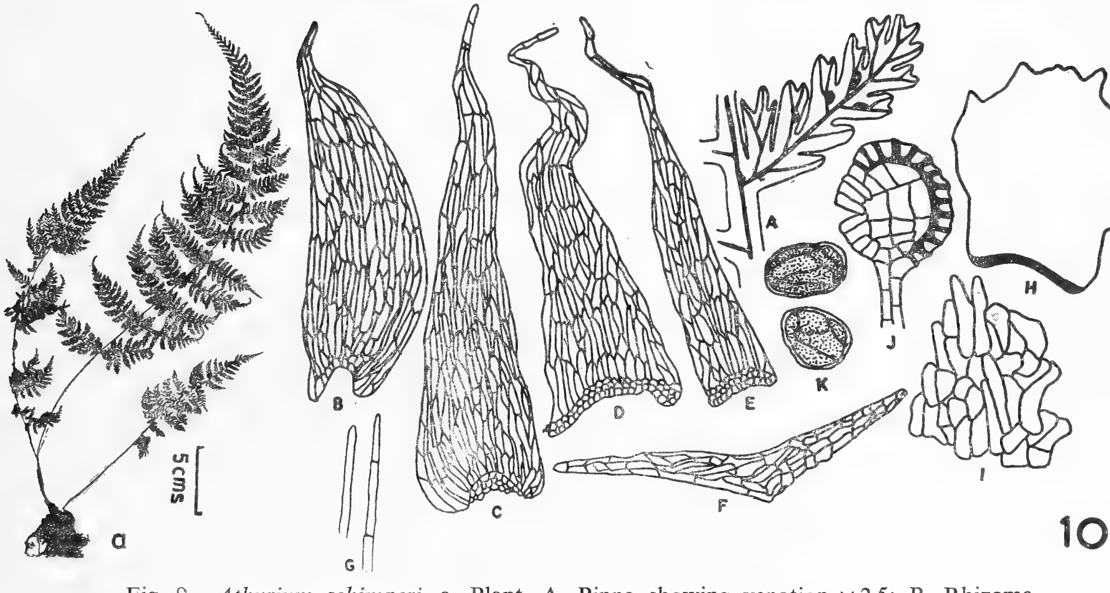


Fig. 9. *Athyrium schimperi*. a. Plant. A. Pinna showing venation, × 2.5; B. Rhizome or stipe scale, × 12.0; C. Indusium, × 12.0; D. Indusial cells, × 54.0; E. Sporangium, × 54.0; F. Spores, × 156.

Fig. 10. *Athyrium pectinatum*. a. Plant. A. Pinna showing venation, × 3.7; B, C. Rhizome scales, × 18.0; D. Stipe scale, × 18.0; E. Rachis scale, × 18.0; F. Spine on surface, × 18.0; G. Hairs on both surfaces along veinlets, × 81.0; H. Indusium, × 51.7; I. Indusial cells, × 81.0; J. Sporangium, × 81.0; K. Spores, × 234.0.

at an altitude of 1,950 m around Nainital.

A. schimperi Moung. ex Fee, Mem. Fougeres, 5 (Gen. Fil.), 187, 1850-52.

Rhizome 0.4-0.6 mm thick, widely creeping, covered with dark-brown, linear-lanceolate, 3-4 mm long, upto 0.5-0.7 mm broad at base scales; fronds distant, yellowish to bright-green; stipes dark-brown at base, firm, erect, having a few scales near the base which are similar but smaller to rhizome scales; lamina variable, 26-30 × 14-18 cm, oblong-lanceolate, bipinnate; pinnae opposite below, alternate above, basal ones reduced; each pinna lanceolate acuminate, 7-8.5 × 1.5-2 cm; pinnules alternate, patent, having decurrent base, sessile, 1.5-2 × 0.8-1 cm, cut down half the way to the costa into 4-6 pairs of segments with serrate margin; texture herbaceous; venation generally forked; sori j-shaped or reniform at maturity, placed along the superior veinlets nearer to the costae, indusiate; indusium broad, firm with an irregularly lobed margin, indusial cells irregular with deeply lobed cell walls; sporangia with 13-14 celled annulus; spores dark-brown, perisporiate, perispore folded giving the appearance of reticulations (Fig. 9).

One of the commonest species of the area, growing in damp, shaded, and humus rich places. Met with near Land's end, snow-view, Lariakanta, and around the lake, between 1,800-2,400 m altitude.

A. pectinatum Presl, Tent Pterid., 98, 1836.

Rhizome 0.4-1 cm thick, widely creeping, branched, covered with yellowish-brown, thin, lanceolate, hair pointed, upto 2 mm long, 0.5-0.8 mm broad at base scales: fronds, tufted; stipes 5-17 cm long, straw coloured, fragile, scaly, scales 4.5-6 mm long, 0.5-1 mm broad at base, lanceolate, hair uniseriate, pointed; lamina 10-45×4-12 cm, lanceolate to subdeltoid with acuminate apex, finely dissected, 3-4 pinnatifid; primary pinnae 15-24 pairs, subsessile, sub-deltoid, acuminate, 4-7 × 2-4 cm. distantly placed, cut down into 7-10 pairs of 0.3-0.5 × 1-1.3 cm pinnules; pinnules further divided into ultimate segments with dentate margin; rachis greenish and grooved but rachilets pubescent with 1-3 celled uniseriate hairs on both surfaces, secondary rachis minutely spiny on upper side; texture subcoriaceous, firm; venation forked; sori small, present on superior veinlet, reniform, indusiate; indusium thin, membranaceous, more broad than long with wavy margin, indusial cells irregular elongated with smooth walls; sporangia with 13-16 celled annulus; spores dark brown, perisporiate, perispore loose and reticulately folded (Fig. 10).

This species inhabits open but rather moist situations along roadside. It is common around Bhowali (1,500 m).

REFERENCES

BEDDOME, R. H. (1883): A Handbook to the Ferns of British India, Ceylon and Malaya Peninsula. Thacker Spink & Co. Calcutta.

BIR, S. S. AND SHUKLA, P. (1966): Pteridophytic Flora of Simla Hills (N. W. Himalayas). Family Athyriaceae. *Bull. Bot. Surv. India, 8;* 264-277.

CLARKE, C. B. (1880): A Review of Ferns of Northern India. *Trans. Linn. Soc. London,* II, Bot., 1, 425-611.

DHIR, K. K. AND DATTA, K. S. (1976): Ferns of Dharamsala hills-2 (North-Western Himalayas). Fam. Woodsiaceae, Aspidiaceae and Athyriaceae. *Nova Hedwigia, 27*: 393-424.

HOPE, C. W. (1899, 1903): Ferns of North Western India. *J. Bombay nat. Hist. Soc. 12*: 527-538; *14*: 119-127.

APPLICATION OF SOME BIOCHEMICAL METHODS IN BANDICOOT TAXONOMY[1]

M. S. Pradhan[2]

(*With four text-figures*)

Introduction

The paucity of information concerning even the most common forms of Indian rodents is particularly noteworthy. The full importance of Indian rodents in India generally is not realised (Spillett 1968). Rodent taxonomy suffers seriously from lack of biological information.

In spite of the fact that field rats directly affect the human populations the taxonomy of the genus *Bandicota* was not clear. Ellerman (1963) while studying the genus divided it into two species *B. bengalensis* and *B. indica* and cleared most of the confusions at generic level. While revising the classification of subspecies of *B. bengalensis*, Agrawal and Chakraborty (1976) reduced the number of subspecies described by Ellerman (1963) from seven to three. They have concluded that there is no difference between *B. b. bengalensis, B. b. kok* and *B. b. gracilis*. Bombay variety of field rat is *B. b. kok* (*lordi*) (confirmation from Bombay Natural History Society, Bombay). Does it also belong to the same catagory of *B. b. bengalensis* or whether it shows some variations, remained unconfirmed. The present paper deals with this problem and some modern taxonomical methods which have not been used so far, like the biochemical techniques, were employed in the present studies.

Materials and Methods

The classification of local stock of *Bandicota bengalensis* was identified and confirmed by the authorities from Bombay Natural History Society, Bombay and it was concluded that the stock belonged to *Bandicota bengalensis kok* (*lordi*) (Ellerman 1963). To avoid errors resulting from the overlapping of characteristics, sexually mature animals were selected for the present studies. The total number of animals studied was 293.

The measurements of the following regions were recorded :-

External measurements: (1) Complete body, i.e. from tip of the snout to tip of the tail, (2) Head + body, (3) Tail, (4) Pinnae, (5) No. of tail rings and (6) Hindfoot.

Cranial measurements: (1) Occipitonasal length, (2) Nasals and (3) Tooth-row.

The standard deviations from means were calculated for each characteristics. All measurements were taken in mm.

Biochemical studies:

The following blood proteins of bandicoot rats were studied. The details are given in author's (1976) thesis for Ph.D.

Haptoglobin and Transferrin: The proce-

[1] Accepted July 1977.

[2] S. S. & L. S. Patkar College, Biol. Dept., Goregaon West, Bombay-400 062. *Present address*: Zoological Survey of India, Western Regional Station, 933/A, Shivajinagar, Pune-411 016, (India).

TABLE 1

SHOWING AVERAGE MEASUREMENTS (IN MM) WITH STANDARD DEVIATIONS OF THE MORPHOLOGICAL CHARACTERS OF *B. b. kok* (*lordi*) $N = 293$

	Complete Body	Head + Body	Tail	Hind Foot	Width eye to eye	Width ear to ear	Tail Rings	Head (only)	Occipito-nasal	Nasal	Tooth row
Arithmatic Mean X	438.67	251.13	188.01	45.00	94.17	110.02	187.29	56.92	45.75	14.7	7.75
Standard Deviation	± 26.91	±19.71	±15.35	±2.08	±7.02	±8.09	±17.55	±4.13	±2.04	±0.92	±1.16

dure adopted for starch-gel-electrophoreses was the same as that described by Smithes (1959). Buffer used was barbiturate buffer with pH 8.6.

Haemoglobin: Paper electrophoresis method described by Pauling *et al.* (1949) was adopted for the present work.

OBSERVATIONS

General: Though known by the name field rat, as its habitat is in general agricultural fields in rural areas, *B. bengalensis* of Bombay region particularly inhabits human dwellings and leads an epizootic life. They are ferocious in nature and when disturbed they make grinding noises with their prominant incisors. The head is triangular, the tail is short, naked with a number of rings on it. The tip of the tail is mostly white.

Fur and its coloration: The animal possesses short hairs. The fur is soft, especially during winter season. The harshness of the fur is felt due to some hard hairs intermixed with some soft hairs. The colour on the dorsal surface varies in all shades from light to dark black brown while undersurface is in gray tones. Some 5-10 red coloured varieties were also caught in urban areas.

External morphological and cranial measurements: Table 1 shows the average measurements of different characteristics with standard deviations from the means. The measurements tally to certain extent with those mentioned by authorities of Bombay Natural History Society for identifying *B. b. kok* (*lordi*). The width of the head at ear to ear region is broadest in comparison with that at eye to eye region; besides, the length of the head is not much elongated like that of *B. indica*. This gives a peculiar triangular appearance to *B. bengalensis's* head. The

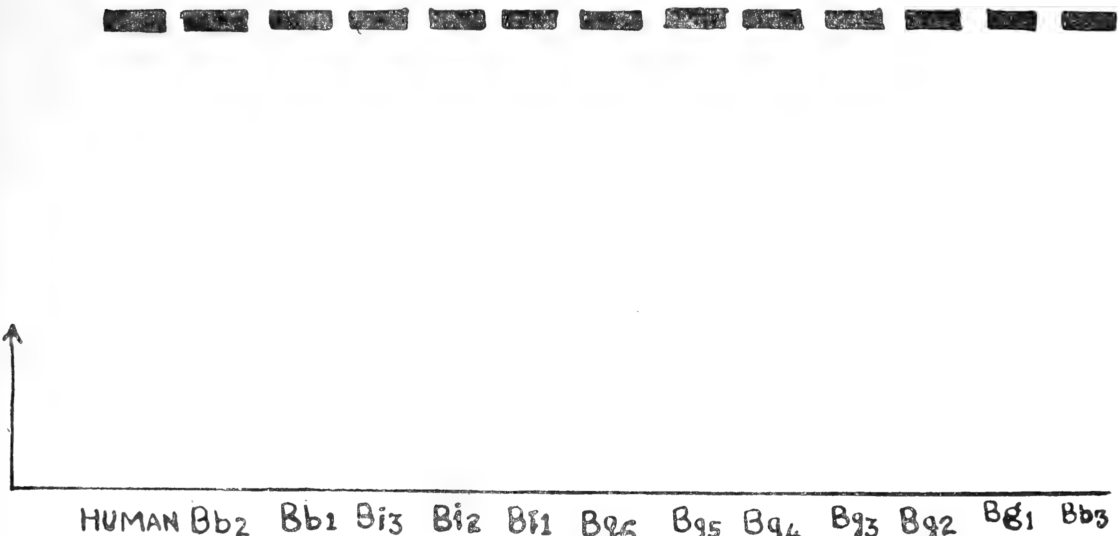


Fig. 1. Diagramatic representation of *Bandicota* haptoglobin patterns by starch gel electrophoresis.

Abbreviations: B.b. = *Bandicota bengalensis;* B.i. = *Bandicota indica;* B.g. = *Bandicota gigantea.*

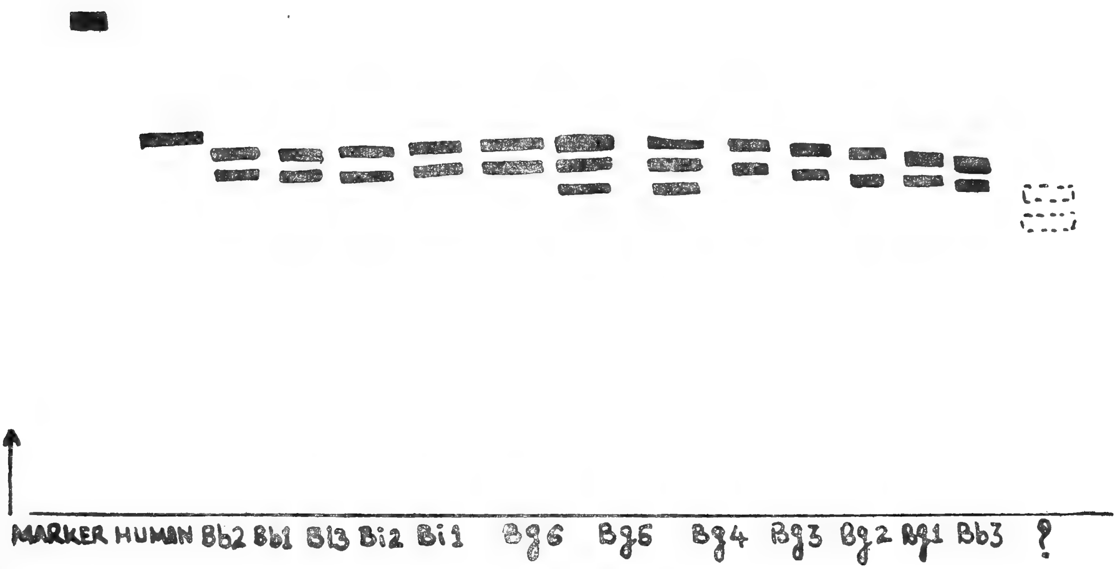


Fig. 2. Diagramatic representation of *Bandicota* transferrin patterns.

Abbreviations: B.b. = *Bandicota bengalensis;* B.i. = *Bandicota indica;* B.g. = *Bandicota gigantea.*

average length of the tail and the number of tail rings are almost same. The rings are stout, complete and well expressed.

Table 1 shows the average measurements of different cranial regions also, *B. bengalensis* possesses a narrow brain case but the width at zygomatic region is comparatively broader. Nasals are short while palatal foramina is long and narrow. The average tooth row was 7.5 mm. The incisors are always yellow in colour as against those of *B. indica* which when alive possesses white incisors.

BIOCHEMICAL STUDIES :

Haptoglobins: Fig. 1 shows the photograph of electropherogram showing that all

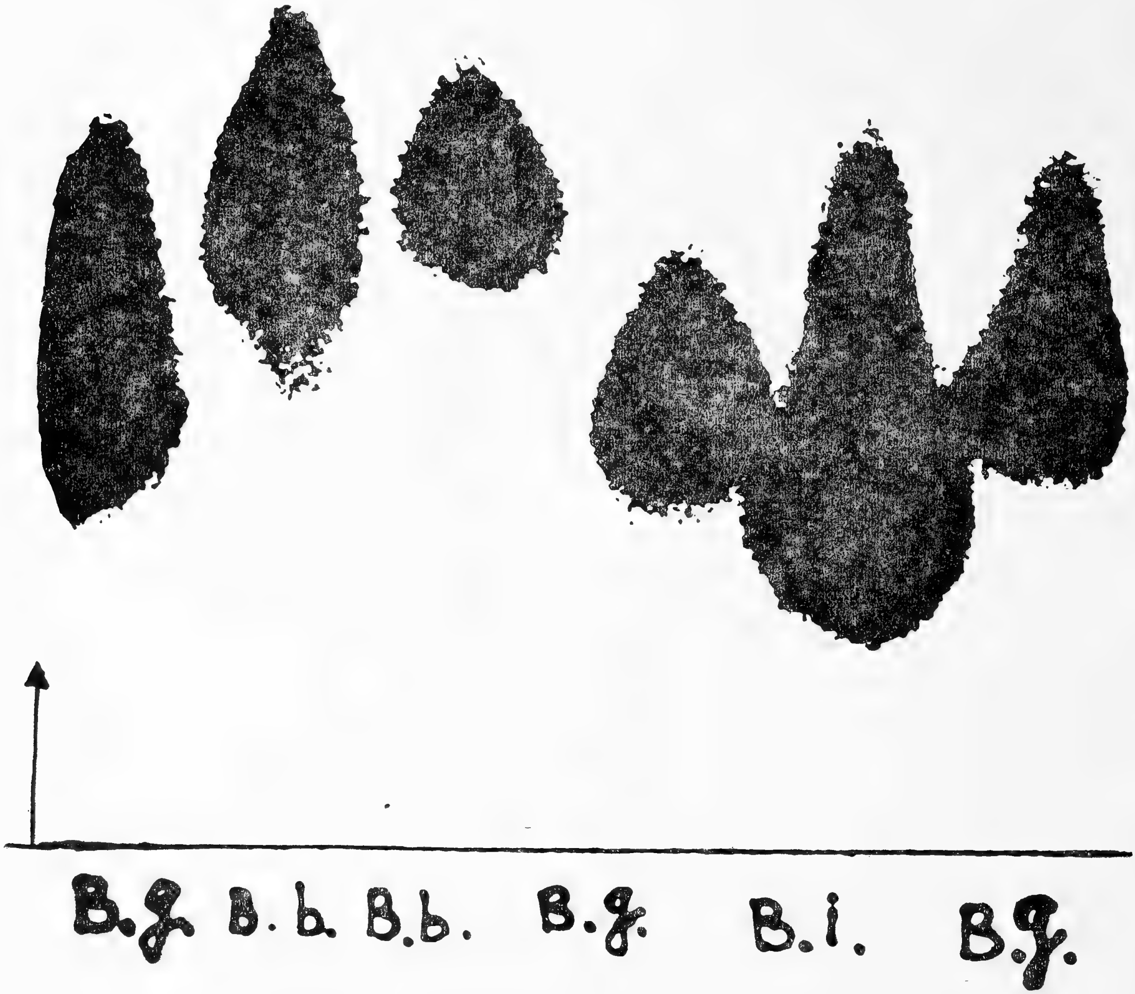


Fig. 3. *Bandicota* haemoglobin patterns by paper electrophoresis.
Abbreviations: B.b. = *Bandicota bengalensis;* B.i. = *Bandicota indica;* B.g. = *Bandicota gigantea.*

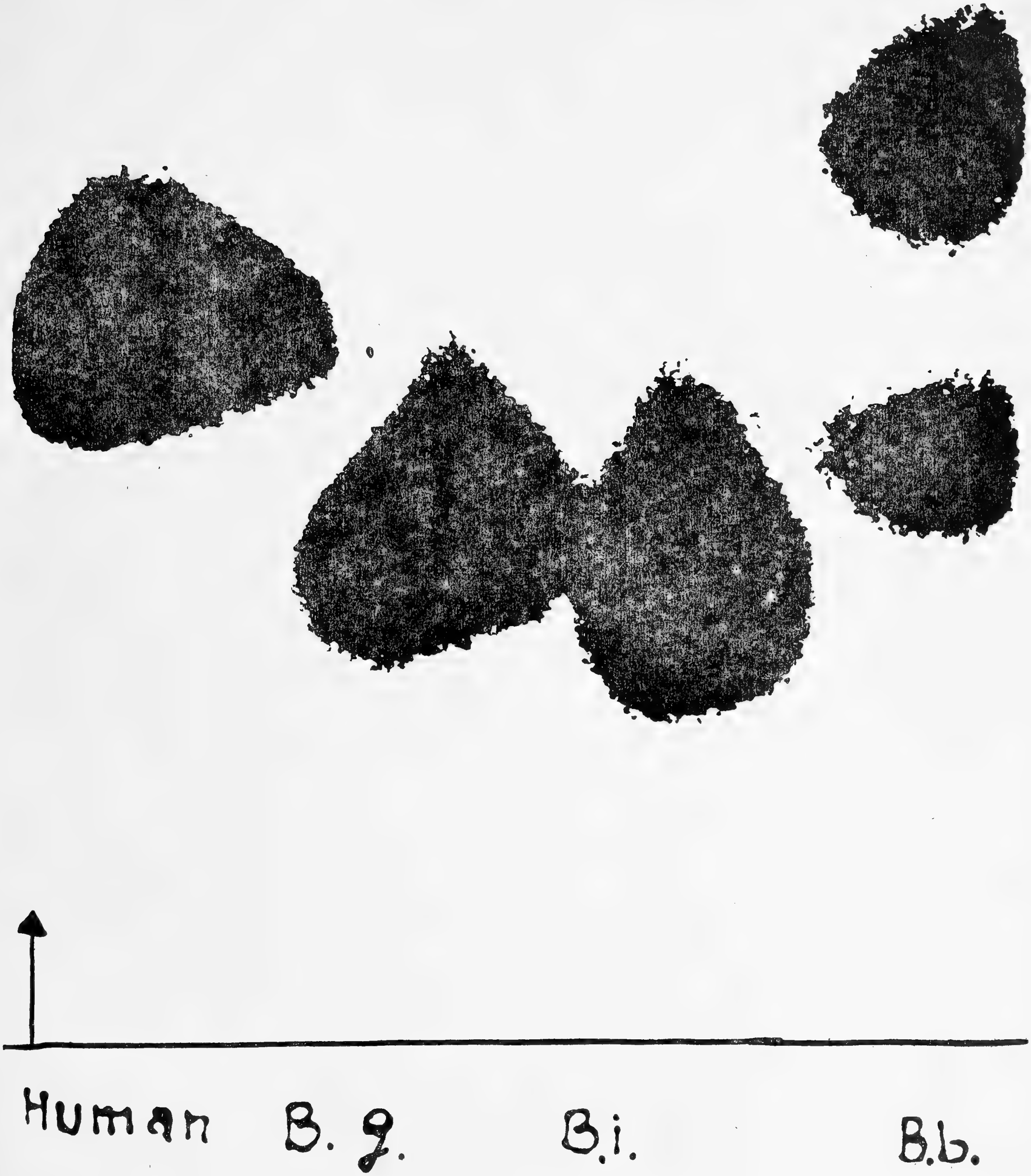


Fig. 4. *Bandicota* haemoglobin patterns showing intrasubspecies haemoglobin polymorphism in *B. bengalensis*.
Abbreviations: B.b. = *Bandicota bengalensis;* B.i. = *Bandicota indica;* B.g. = *Bandicota gigantea.*

TABLE 2

SHOWING COMPARATIVE ACCOUNT OF MEASUREMENTS (IN MM) OF DIFFERENT SUBSP. OF *B. Bengalensis*

Name of the sp.	No. of examples	Reference	Head +Body	Tail	Hind foot	Occipitonasal	Tooth row
B. b. bengalensis	115	Agrawal and	132-237 (139)	99-202 (148)	29-39 (33.0)	33.3-45.5 (39.1)	5.9-8.0 (7.15)
B. b. kok	106	Chakraborty 1976.	128-243 (165)	100-217 (149)	27.44 (33.5)	33.8-45.5 (39.0)	6.3-8.0 (7.25)
B. b. gracilis	14		167-202 (184)	121-170 (140)	28-35 (32)	35.8-42.0 (39.2)	6.2-7.0 (6.7)
B. b. kok (lordi)	293	Pradhan 1976	251.13 ±19.71	188.01 ±15.35	45.00 ±2.08	45.75 ±2.04	7.75 ±1.16

Figures in brackets : Arithmatic Mean X

the species of genus *Bandicota* possess 1/1 (Normal) type of haptoglobin, comparable to that of human type. The mobility of all the haptoglobins was same.

Transferrins: Fig. 2 shows the photograph of bandicoot transferrins. It was observed and confirmed that the field rats, like *R. rattus,* possessed 2/2 types of transferrins in the region of B-2 globulin zone comparable to those reported earlier (TfR and TfN) by Yoshida *et al.* (1971). The mobility of all the types was same. One exceptional type of *B. gigantea* showed the possession of an additional Tf band. This is probably a heterozygous crossbreed of the two different homorygous types of transferrins occurring in the nature (The second probable type is shown in dotted line).

Haemoglobin: Fig. 3 shows the photograph of paper electropherogram showing differences in the mobility of 1/1 type of *Bandicota* haemoglobin. Almost all the samples possessed 1/1 type. *B. bengalensis* haemoglobin has a faster mobility than human type. It probably belongs to HbJ type (Anonymous 1964). One type of *B. bengalensis* was found to possess both the types [Hbs HbJ] of haemoglobins (Fig. 4). The occurrence of two haemoglobin bands in that peculiar sample was confirmed by repeating the run.

DISCUSSION

Agrawal and Chakraborty (1976) while comparing the different subsp. of *B. b. bengalensis* confirmed that all the three varieties (*B. b. bengalensis, B. b. kok,* and *B. b. gracilis*) should be kept in a common group of *B. b. bengalensis.* The Bombay variety, which is predominant in this area, is *B. b. kok* (*lordi*). If the morphological measurements

are compared with those mentioned by Agrawal and Chakraborty (1976) it would be observed that *B. b. kok* (*lordi*) is larger in size than the above mentioned three subspecies in most of the respects (Table 2). But the general pattern and coloration do not seem to vary much. Certain key characters like length of hind foot, tooth row etc. show variations to certain extent. The only point of difference lies in the occipitonasal length. All the skulls of mature animals possess the longer occipitonasal length. But the deviation from the standard length mentioned by Ellerman (1963), Agrawal and Chakraborty (1976) does not bring about any change in the general pattern of skull or even in the structure of head.

From the above mentioned points it is apparent that the variety *B. b. kok* (*lordi*) may be the larger form of *B. b. bengalensis* and it will not be wrong to merge this variety with *B. b. bengalensis*. This view may also be supported by biochemical tests of haptoglobin and transferrins [TfR and TfN patterns] which do not show any differences even at generic level. Based on morphological differences like measurements and coloration *B. b. bengalensis* and *B. b. kok* (*lordi*) have been differentiated as two different subsp. But these characters are insufficient to separate these types. It has also been supported by merging some varieties in *B. b. bengalensis* by Agrawal and Chakraborty (1976). But even if this view is accepted, *B. b. kok* (*lordi*) cannot be merged in *B. b. bengalensis*. Because, the genetical differences in haemoglobin patterns still confirm the existence of intra-subspecific polymorphism amongst the subspecies. If other slow moving Hbs type is located, it will be easier to compare the two types even though there exists the morphological differentiation between them.

Acknowledgements

I wish to express my deep sense of gratitude to Dr. P. J. Deoras, Prof. Emiritus, Patkar College, for his valuable guidance. The author is thankful to Principal, S.S. & L.S. Patkar College, Goregaon West, Bombay-62, for providing the laboratory facilities; to Dr. S. N. Naik, Animal House In-charge, Tata Cancer Research Institute, Bombay, for his suggestions and also to Dr. B. K. Tikader, Deputy Director, Zoological Survey of India, Poona, for his cooperation.

References

Agrawal, V. C. and Chakraborty, S. (1976): Revision of the sub-species of the lesser bandicoot rat *Bandicota bengalensis* (Gray) (Rodentia: Muridae). *Rec. Zool. Surv. India,* (69): 267-274.

Anonymous (1964): Nomenclature of haemoglobins. *Brit. Med. J.,* (5419): 1258.

Ellerman, J. R. (1963): Fauna of India, Mammalia, Vol. 3, part 2. Edited by Roonwal, M. L. Publ. *Zool. Surv. India,* Calcutta, pp. 884.

Pauling, L., Itanoh, A., Singer, S. T. and Wells, I. C. (1949): Sickle Cell anaemia, a molecular disease. *Science, 110*: 543.

Pradhan, M. S. (1976): Studies on Bombay Rats. Ph.D. thesis in Zoology, Bombay University.

Smithes, O. (1959): Zone electrophoresis in starch gels and its application to studies of serum proteins. *Advanc. Protein Chem., 14*: 65.

Spillett, J. J. (1968): The ecology of the lesser bandicoot rat in Calcutta. D.Sc. thesis in Zoology, *Cal. University,* pp. 224.

Yoshida, T. H., Kato, Hatao, Kimiyuki, T. and Moriwaki, Kazwo (1971); Karyotypes and serum transferrin patterns of hybrids between Asian and Ocenian black rats, *Rattus rattus. Chromosoma, 34*(1): 40.

PRELIMINARY CROCODILE SURVEY—SRI LANKA[1]

R. WHITAKER AND Z. WHITAKER[2]

(*With eight plates*)

INTRODCTION

The investigators were invited by the Sri Lanka Wildlife and Nature Protection Society to undertake a crocodile survey of the Island. Due to political tensions the survey was underway only by the 20th of September 1977. The investigators arrived by ferry at Talaimannar and started on the road by Jawa Motorcycle from there via Anuradhapura via the coast and thence south to Hambantota and Yala north to Uda Walawe, east to Kumune and Pottuvilp, north to Amparai and Batticaloa, north and west to Polonnaruwa and Anuradhapura and north to Mullaitivu, Elephant Pass, Mahawilachhiya, and then south to Colombo on the inland route. Detailed, proforma based data were gathered for 40 representative tanks during the survey which lasted till November 1st. In addition, hundreds of ponds, reservoirs, streams and rivers were examined, local crocodile censuses taken, local residents interviewed and general data pertaining to crocodiles was gathered.

(1) The first part of the following report will give excerpts from writings of early naturalists and explorers which invariably point to the great abundance of both the species of crocodiles of Sri Lanka—the freshwater marsh crocodile or mugger (*Crocodylus palustris*) and the saltwater or estuarine crocodile (*Crocodylus porosus*). These are variably called hale kimbula and gette kimbula in Singhalese according to the part of the country. To help regularize vernacular names we might adhere to what seems to be in widest common use is hale kimbula (sluggish) for *C. porosus* and gette kimbula (rough-skinned) for *C. palustris*. In Tamil, *C. palustris* is often known as kulathu (tank) muthalay and *C. porosus* semmukan (copper nosed) muthalay or kadal (sea) muthalay.

(2) The second part will be the Island with relation to its 300,000 acres of estuarine habitats and 100,000 acres of tanks. One outstanding feature is that there are no natural freshwater lakes. The over 10,000 man made tanks were constructed between the 5th century BC and 14th century AD, providing greatly expanded habitats for *C. palustris*. *C. porosus* probably benefitted by the mugger's possible shift from the rivers and lagoons.

(3) The third part of the report traces the recent history of the crocodile in Sri Lanka, starting from the 1930's.

(4) Part Four describes the findings of our recent 40 day trip (Sept.-Nov., 1977) through the Island's main crocodile habitats, including data from a fortnight's visit in August 1976. The appendix includes a list of places actually visited by the investigators during the survey with a brief summary of findings at each location of previous or present crocodilian importance.

(5) Part Five is the conclusion and outlines the value of crocodiles in the wild and suggests conservation measures.

[1] Accepted May 1978.

[2] Madras Snake Park Trust, Madras-600 022.

Above: Canal near Negombo draining Muthurajuvela swamp.
Below: *Crocodilus porosus* hatchling found near Colombo.

Above: *Lagenandra,* along the Nilwala Ganga; remnants of once dense *C. porosus* habitat. *Below*: Crocodile proof bathing fence on the Nilwala Ganga.

Methods and Equipment

Low budget survey techniques deserve a more important place in the field of conservation. The need for continual monitoring of populations of critically endangered and exploited species and the importance of the initial investigations into census and status are obvious. Conservation organizations could continue to encourage "semi-formal" surveys toward the eventual goal of having an up to date/accurate picture of the status of species threatened by habitat loss or poaching. Wildlife Departments could open a Survey Wing with interested field staff and cooperation with the University and all the numerous government agencies which already have the means to collect data on most forms of wildlife in need of surveys and possibly protection/rehabilitation. Discussion with local residents is most rewarding but one must gain experience in judging levels of exaggeration and confirm crocodile size and population estimates by personal observation. It is a universal tendeny to over estimate size and numbers of crocodiles seen.

Early writings on Crocodiles

1. "Few reptiles are more disgusting than these brutes; but, nevertheless, their utility counterbalances their bad qualities, as they cleanse the water from all impurities. So numerous are they, that their heads may be seen in fives and tens together, floating at the top of the water like rough corks..." Baker, 1855.

2. "Among these (creeping things) the Crocodile comes before all other, since it is very great both in number and size..." Heydt, 1744.

3. Chit Aru (near Giants Tank) "abounds in alligators." Ward, 1859.

4. Insurumuniya Temple—"Before and behind lie large lotus ponds on whose banks huge crocodiles may be seen...the monks now resident have placed it at the disposal of the crocodiles whom they encourage by providing them with food." Cave, 1900.

5. "This is the one (*C. palustris*) so common in the tanks of the Jaffna peninsula." Ferguson, 1877.

6. "All the (low country) tanks, rivers and forest pools swarm with them (crocodiles)." Clark, 1901.

7. "Among the amphibious creatures, the Kaiman, or crocodile, call'd Lagarto by the Portugueses, is very frequent here; some of which are eighteen feet long. They have four feet with crooked claws, their skin covered with scales, which are so hard on the back, that they are musket proof...In Jafnapatnam there are many crocodiles in the fens, ponds and lakes; which if they happen to dry up in the summer, they dig holes to live in..." Baldaeus, 1671.

8. "...to the present day the Europeans apply the term alligator to what are in reality crocodiles, which literally swarm in the still waters and tanks throughout the northern provinces but rarely frequent rapid streams and have never been found in the marshy elevations among the hills."

"The lagoon of Batticaloa, and indeed all the still waters of this district are remarkable for the numbers and prodigious size of the crocodiles which infest them."

Mullaitivu: "The fort is surrounded by the remains of a military ditch of considerable depth, and, as usual, filled with crocodiles... Another inlet of the sea which we crossed on leaving Mullaitivu was also swarming with these creatures." (Tennent, 1859).

9. "The alligator of Ceylon is never seen in rivers amongst the mountains or hills: it is

confined to the low country, and abounds most in the lakes and tanks in the northern and southern parts of the island." Davy, 1821.

10. "In all probability it was this reptile (estuarine crocodile) which was so petted by the Portuguese soldiery at Malwara, Colombo, Kalutara and other river forts; and Kayman's gate in Colombo perpetuates the memory of their former abundance." Deraniyagala 1930.

11. "On any bit of bank or rock projecting out of the water you are certain to see numbers of loathsome crocodiles basking open-mouthed in the sun..." (in the N.C. Province) Storey, 1907.

12. Nanthi Kadal..." where we saw so many crocodiles and innumerable birds above them..." Falck, 1767.

The Island: Freshwater and Estuarine Habitat

Sri Lanka lies between the 5th and 10th parallels and except for the high hills has a year round tropical climate. The island is 25,332 sq. miles in area and composed of three well marked plains of erosion termed "peneplains." Each peneplain has developed a characteristic fauna whose distribution is affected by temperature and rainfall. The dry zone comprises most of the coastal and low country area, it receives less than 75 in. of annual rainfall. The wet zone is mainly on the south west coast and the 2nd and 3rd peneplain and receives over 75 in. of rain.

Sri Lanka has 34 major river drainages. 7 are in the dry zone, 2 in the dry and wet zones, 25 in the wet zone. The major wet zone rivers are perennial, the dry zone rivers shrink in the dry season and may dry in drought.

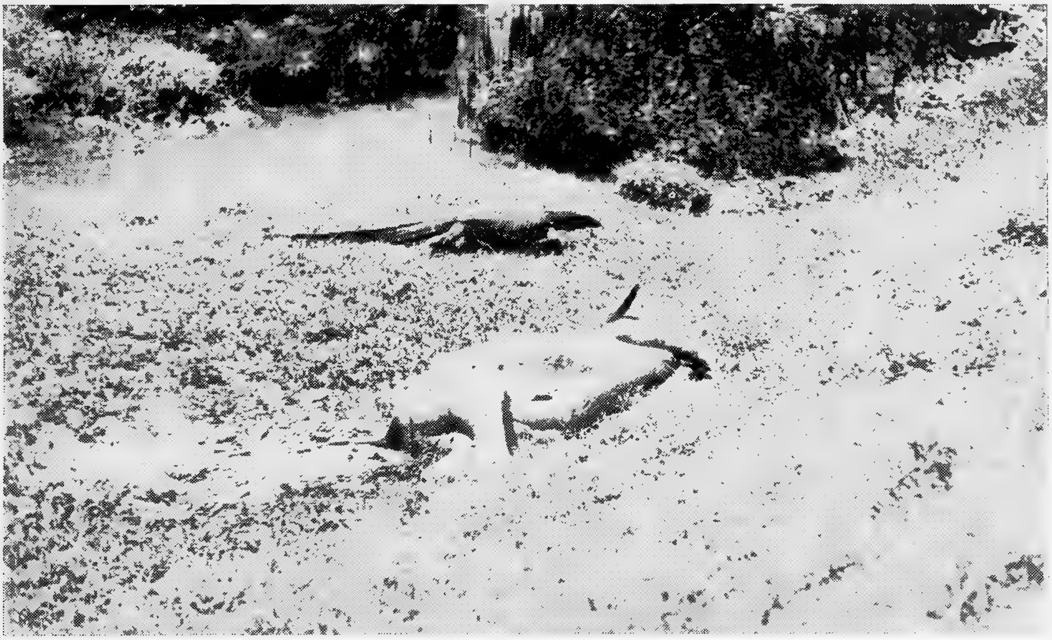
There are no natural freshwater lakes in Sri Lanka. Rivers and streams were dammed from about the 5th century B.C. and major tank construction continued till about the 13th century AD. Most of the 1st peneplain dry zone was colonized then and in the 11 million acres of this area over 10,000 tanks were constructed with a complex network of channels.

The human population in those days is estimated at 10 million. Invasion and drastic population decline shortly thereafter caused much of what was once farmland to revert to forest. The tanks which became jungle tanks, (some of which lie within the present National Parks), became the main crocodile habitat.

The term "tank" is conveniently applied to any man made body of freshwater whether it is a village tank of an acre or the Senanayake Samudra Reservoir which is 19,000 acres. Since these form the main *C. palustris* habitats of Sri Lanka it would be appropriate that a study of the crocodile's role in tank biology be undertaken.

Mugger are also found in many of the main rivers notably the Mahaweli Ganga and the Yala stretch of the Menik Ganga. There is little reference to march crocodiles in rivers in the old literature and in interviews and we found that though scattered, small populations exist, concentrations of mugger only occur in tanks. Crocodiles have rarely penetrated to the 2nd peneplain. Deraniyagala and others report crocodiles in low-land lagoons, salt pans, river deltas, canals and and swamps, and in isolated instances on the 2nd peneplain. This year a crocodile was observed for the first time at Gampola near Kandy, an elevation of about 450 m. It was possibly an escapee from captivity (da Silva 1977).

There are numerous references in literature of crocodiles in the salt pans of the southeast and the salty wilas of Wilpattu. These are mugger and seem to be able to tolerate concentrations of salt higher than sea water for long



Above: The water monitor, important predator on crocodile eggs, is common in south-west Sri Lanka. *Below*: Small tidal affected stream in southern Sri Lanka. Habitat of *C. palustris*.

Above: Palatupana Lagoon near Yala. Saline habitat of *C. palustris*. *Below*: The Wila Oya stream as it flows into Panama Tank. Largest concentration of *C. palustris* was observed here.

periods. During the dry season when the shallow salt lakes (occasionally connected to the sea via a small lagoon) shrink, the salt concentration causes a massive fish kill on which crocodiles, birds and other scavengers feast (Spittel 1924). Near Palatupana we found a group of 2 week old hatchling mugger in lagoon water of 3.38% salinity. It had been thought that up to a certain age juvenile crocodiles cannot tolerate such a concentration. The edge of the lagoon was strewn with dead and dying mullet (*Mugil* sp.)

Other occasional *C. palustris* habitats include unlikely places like deep pools in small streams, old wells and urban and suburban weed-choked canals. Although big, breeding size mugger are generally too conspicuous to survive for long near human habitation, smaller individuals often do very well if they learn how to stay out of sight. Deraniyagala mentions that *C. palustris* favours the sycamore (*Terminalia arjuna*). Tree root systems overhanging river and pool embankments provide perfect tunneling habitat.

The estuarine crocodile (*C. porosus*) is a completely different animal and prefers a different habitat. Just inland of the sea on the western coast beginning at about Puttalam and going south, is a stretch of intermittent swampland. Much of this been cleared, drained and converted to paddy land and even filled in; but considerable areas remain. The best areas are centred around the main rivers draining into the sea on the southwest and southern coasts. The Maha Oya, Kelani Ganga, Bentota Ganga, Gin Ganga and the Nilwala Ganga were once famous for crocodiles.

The remaining swampland, comprised of mangrove, cane, flag grass, pandanus and other thick semi-aquatic vegetation, is an ideal home for *C. porosus* and indeed, Sri Lanka's main remaining breeding population appears to exist on this coastal strip. The lagoons of Pottuvilp, Batticaloa, Trincomalee and Mullaitivu may once have harboured considerable *C. porosus* populations (see old refs.), but no more. One well known estuarine crocodile reported to be 5-6 mts in length is seen regularly between Panama and Kumune on the south east coast and apparently a few are left in some of the denser mangrove thickets north of Trinco. This is a more or less solitary animal as compared to the gregarious mugger. The female requires a very secluded, undisturbed area to build her metre high, conspicuous nest and the available habitat is considerably diminished. The proposed Free Trade Zone between Negombo and Colombo will cause further inroads as the Muthurajavela swamp is cleared and drained. This animal needs a sanctuary if it is to survive in Sri Lanka. *C. porosus* has not been reported far inland in Sri Lanka. It apparently will not dwell in the same area as *C. palustris* and, as elsewhere in its range, it probably keeps its own preferred area clean of mugger. Deraniyagala writes that *C. porosus* is associated with mangrove and flag grass (*Lagenandra*).

There is still much to be discovered as to the distribution of Sri Lanka's two crocodiles. Their habitat preferences tend to generally separate them but there are obvious overlaps. Mugger are generally easily observable as they tend to live and bask in open areas; the estuarine crocodile is generally more shy, and more apt to stay hidden. Even night survey techniques may be far from accurate in areas where heavily hunted crocodiles become "light shy" and remain only in the least accessible coastal and river delta mangroves.

The natural habitat of crocodiles in Sri Lanka has been further altered by thousands of miles of man made canals and channels of

many proportions and functions. In some cases these modifications are beneficial to crocodiles, offering alternate habitat, hunting habitat and access to other tanks.

Recent history of Sri Lanka's Crocodiles

"No longer do crocodiles bask in the sun in the tanks of Ceylon. The avariciousness of man has all but exterminated them. Although these antediluvian monsters are not beautiful to look upon, yet they are part of nature's scheme and did give a certain charm to the tanks. Man set up a factory, seeking quick wealth from the tanning of crocodile skins; and within ten years, he has to close down the factory because there were no crocodiles left to tan" (Hennessy 1949).

"The great demand for crocodile skins tends to thin out considerably the numbers of these reptiles so much so that in recent years it has not been unusual to see in tanks affected by drought hundreds of fishes which would have fallen prey to the voracious creatures lying dead on the dried up bed there to putrefy and cause ill health to the people residing in the adjoining areas." (Somanader 1941).

Deraniyagala writes similar bleak findings. He wrote that crocodile hunters take a heavy toll of mugger in the dry season using large-meshed 'kimbul dale' (crocodile nets) and harpoons and that "the species which was so common in 1925 is now rarely found in any numbers and specimens 3 metres long are very scarce," (Deraniyagala 1939). Regarding record size he mentions 2 of about 5.25 mts. ($18\frac{1}{2}$ ft.) shot in 1916 in Kantalai Reservoir. He further states that before hide hunters reduced numbers (during the late 1920's and early 1930's) "troops of over 100" *C. palustris* could be commonly seen basking on bunds of reservoirs. He maintains that this species has become scarce along the coast with the spread of firearms.

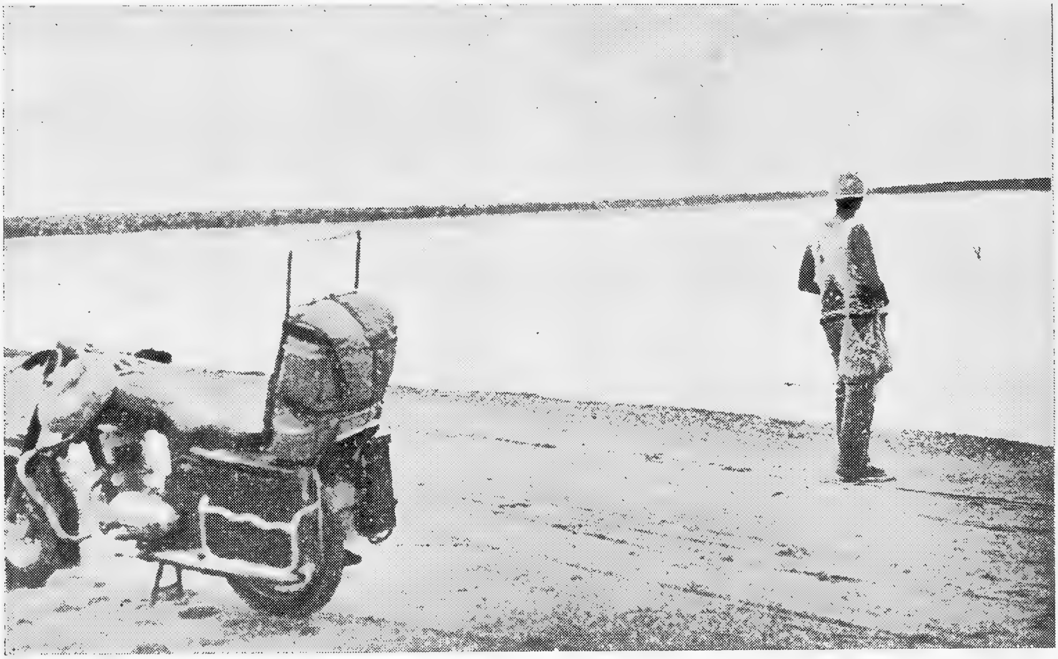
Regarding *C. porosus,* little has been written of its previous abundance but judging from the excellent habitat which was available for the species it must have been plentiful on much of the coast.

We searched through records in the Chamber of Commerce, Colombo, but apparently crocodile skins were included in the general "hides" category for there are no statistics. It is unknown how many skins were contributed to the world trade (which has fluctuated from 2,000,000 to perhaps 10,000,000 skins per year) but the fact remains that crocodiles were considerably depleted by the late 1930's.

In 1946 crocodiles were placed on Schedule IV of the Fauna and Flora Protection Ordinance which means they cannot be shot without a Special License, allowing one crocodile to be taken. The export of crocodile skins is totally banned. Combined with adequate habitat protection it would seem that these laws, if enforced, would ensure the future of Sri Lanka's crocodiles. The two factors running against that supposition are the sale of dry crocodile meat (without the risk of dealing in the skins) and the chance of smuggling of skins to India. In late 1975 the Indian Excise authorities seized 86 crocodile skins at Dindigul with markings on the crate indicating that it had come from Sri Lanka via the ferry to Rameswaram. We examined the skins during the auction in Madras and they were apparently of the Sri Lanka race of *C. palustris.* Since crocodile protection is now being enforced in India the rarity of skins has put the price up considerably and sources from neighbouring countries like Sri Lanka are obviously being examined by the illicit dealers.

In 1976 four crocodiles were caught in the Mahaweli Ganga in a trapping operation or-

Above: Large tanks of North and North central Sri Lanka used to contain large numbers of *C. palustris*. *Below*: Stumps of thousands of trees protrude from many of the tanks reclaimed from the jungle in the past 50 years such as here at Mahakandarawa Wewa.



Above: The larger, perennial tanks, such as Iranamadu (North Sri Lanka) contain fewer crocodiles than the drought affected smaller tanks of south eastern Sri Lanka. *Below*: Crocodiles migrate to permanent water as the annual tanks turn into swampy grassland in the dry season.

ganized by a local MP (Loris, June 1976). We heard several other similar reports of crocodiles killed by police after allegedly attacking humans. Large crocodiles occasionally do attack humans just as may (in India) the rare man-eating tiger. Crocodile attacks will not happen when basic precautions are taken. People have lived in close proximity to good crocodile habitat well stocked with crocodiles for centuries. In some places, such as the Nilwala Ganga, when an occasional oversized crocodile became a "nuisance crocodile" and attacked humans or dogs, it was generally caught or killed. In some bathing areas along the river wooden fences are built to keep out water weeds and inquisitive crocodiles. In Vol. XII No. 3 (1971) of Loris the Editor remarks "Crocodiles are threatened with extinction all over the world. In Ceylon this is true of at least the Estuarine Crocodile (*C. porosus*)."

Crocodile survey results

In August, 1976 the authors spent a fortnight in the southern part of Sri Lanka visiting crocodile habitats with a herpetologist colleague in Ruhunu National Park and adjacent areas and resolved to return for a more intensive survey in 1977. We approached the Wildlife and Nature Protection Society of Ceylon for funds to support the survey and the Committee approved our grant request for Rs. 3,500. Together with the Rs. 3,500 sponsored by the Madras Snake Park Trust for the survey, we were able to spend 40 days in Sri Lanka, our assistant and ourselves covering about 4000 Kms. by motor cycle, 1000 Kms. by jeep and car plus boat travel and foot work. We visited representative tanks, reservoirs, rivers, lagoons, and backwaters in every district in which crocodiles occur and made a detailed coverage of 40 tanks plus several lagoons. Due to transport and weather limitations we were unable to make adequate coverages of the two large national parks and the wilderness area south and east of Wasgomuwa. These brief periods spent in the crocodile habitat in Sri Lanka provided an excellent general picture of the current status and direction of the two species. The mugger still survives in small numbers in almost every District with concentrations as of the "old days" in the two main National Parks. The skin industry already written about brought the populations down and the current meat industry is holding them down. The estuarine crocodile succumbed to the same pressure but shows less recuperative powers and has lost much of its habitat. The trip diary and summarized results appear in the appendix following the Conclusion.

Conclusion

There is no doubt that crocodiles are an essential ingredient in the healthy ecology of tanks, reservoirs, rivers and lagoons in a tropical country like Sri Lanka. For reasons both religious and cultural and due to the efforts of the W.L. Dept. the two species of crocodiles of this island have retained a better foothold than throughout the rest of their territory.

The Alligator is being protected in America for its value in the swamp ecosystem. The habit of the Nile Crocodile of feeding on predatory fish is earning its rehabilitation in Africa. In India massive FAO/UNDP technically aided projects are underway to save the gharial (*Gavialis gangeticus*) from extinction and help recuperate the two species of crocodiles as valuable renewable resources. In Papua—New Guinea similar UNDP projects have been underway for several years.

Many tanks in Sri Lanka have some forest cover. This is of importance not only in the vital role of preventing erosion and siltation

but also in providing wildlife habitat. The annual tanks of the south-east and north-west parts of the Island are now the most dynamic crocodile habitats. The annual drying up of these tanks provides the crocodiles with several months of easy food availability. These parts of the country are among the least densely populated and include the two National Parks, Ruhunu (240 sq. miles) and Wilpattu (280 sq. miles). These are not only Sri Lanka's most dynamic populations, they are also most vulnerable, to drought.

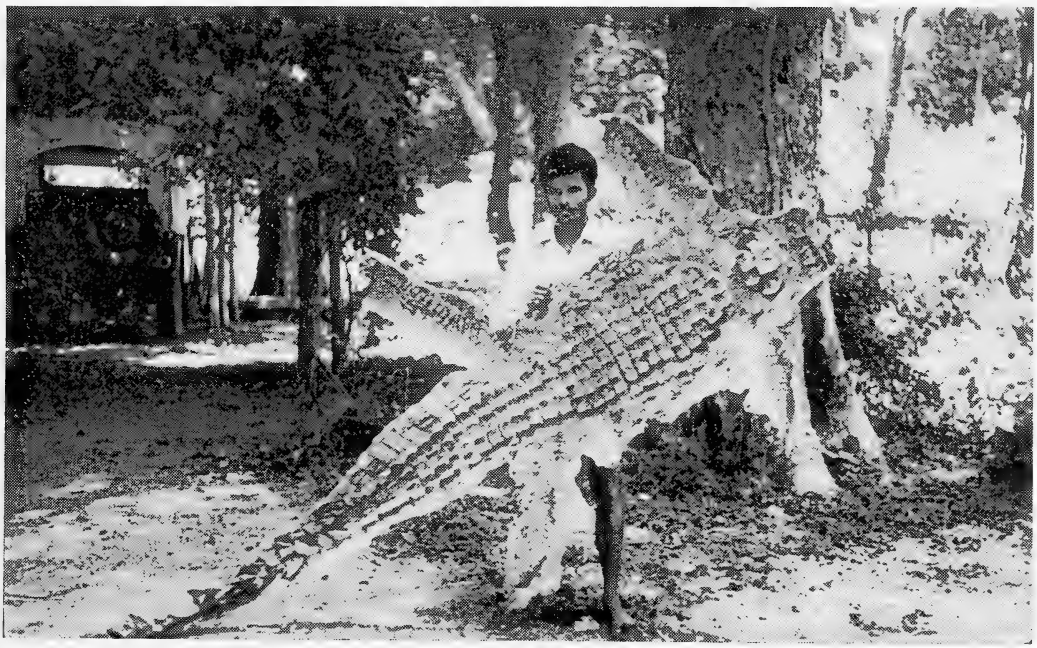
The mugger would be fairly easy to rehabilitate in many parts of the country where the tanks are remote from disturbance or where local residents would not discourage a healthy population (as is still the case at present in several areas like Panama Tank and in the Mullaitivu area). Crocodile killers are usually groups of itinerant fishermen. Since the tanks are generally under the Irrigation Board there are rarely any Wildlife Department staff nearby and no routine checks made.

The estuarine crocodile is a more difficult animal to provide suitable undisturbed habitat for and most coastal habitat is becoming well settled. It would be timely for one or more *C. porosus* habitats to be examined for suitability as preserves for this dwindling species.

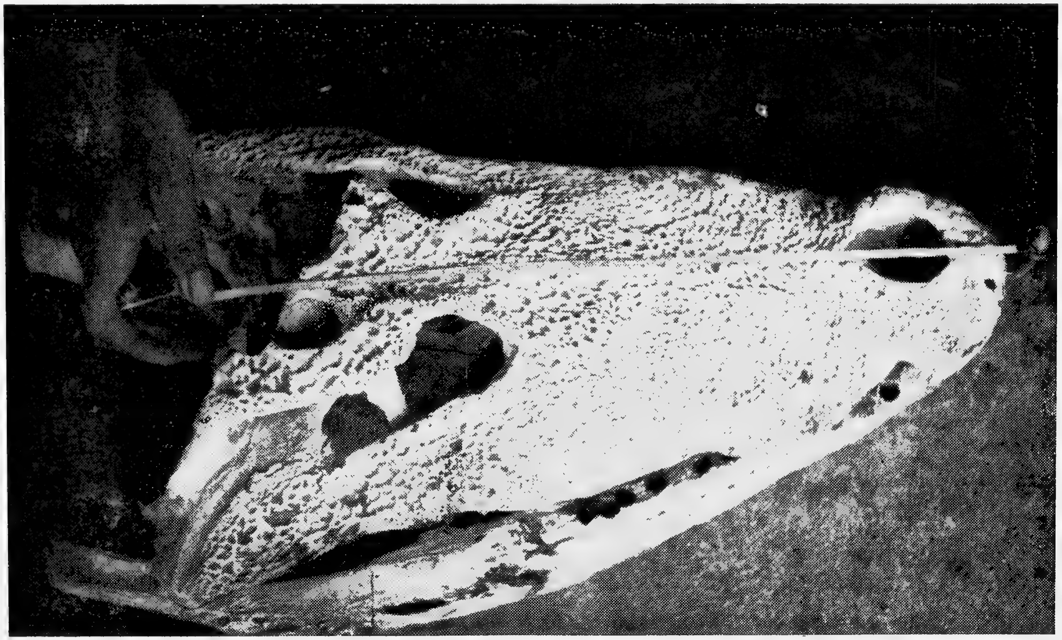
In the case of both species several important measures could help conserve them: (1) Further, detailed survey work to map out exact distribution and status; monitoring and periodic census checks are especially important in populations of reptiles like *C. palustris*. Their vulnerability in drought, their cross country migratory habits due to drought or disturbance, and the variable success of fishermen in seasonal crocodile killing makes the *C. palustris* population of Sri Lanka a rapidly changing picture. (2) Indexing of available habitat for suitability as crocodile preserves. (3) Strict enforcement of existing laws protecting crocodiles by increasing field wildlife protection staff, publicity and cooperation of police, customs etc.

The Colombo Zoo could set up an effective "rehabilitation and rearing centre" for the "orphan" and nuisance crocodiles that continue to be brought in as habitat inroads progress. When suitable crocodile preserves have been identified and protection guaranteed, stock being reared in this crocodile "bank" could be used for restocking these wild habitats. A squad of expert crocodile handlers could be trained to deal with crocodiles guilty of attacks on live stock or humans which should be caught and transferred. Officers of the Wildlife Service in Florida, U.S.A. receive this sort of training.

The association of on going studies of crocodile habits would help wildlife staff solve complex problems such as homing behaviour, migration, territory, population densities, survival in drought conditions, and the role of crocodiles in the tank and estuarine ecosystems. The concept that the ecological roles of all wildlife are relevant to our environment is gaining in favour, it remains to document the crocodile's specific value and place in Sri Lanka's acquatic and brackish habitats. The past decade has seen a great upsurge in the interest and growth of Inland Fisheries. Many large scale fisheries have come to grief in other parts of the world when the crocodiles were wiped out (India included). Crocodiles were accused by fishermen as being competitors for fish and wrecking nets when accidentally entangled. Actually, crocodiles may feed more on the sedentary species of predatory fish such as cat fish (*Bagarius, Wallago*) than the fast and active edible carps (Cott 1961). Crocodiles control numbers of other fish predators including otters, water birds, snakes, turtles, and carnivorous water beetles. The scavenging role of



Above: It has been many years since crocodiles have been seen in and around the Jaffna Lagoon. *Below*: A *C. palustris* accidentally run over by a bus near Senanayake Samudra.



The largest *C. palustris* skull we measured in Sri Lanka. Nosetip to occiput: 51.5 cm; lower jaw 66 cm; the crocodile was said to be 13½ feet long.

crocodiles is well documented and appreciated but there are many more subtle yet important ways in which crocodiles fulfill an important function in nature. A scientist studying caiman on the Amazon determined the nutrient role of these relatives of the alligator and their importance to the fish productivity of the waterways (Fittkau 1970, 1973).

In several cases good crocodile habitat lies within sanctuaries already formed by the Government. Unfortunately there is little field protection afforded to these areas (aside from the major National Parks). Besides further survey and study the serious job of crocodile protection must be strengthened by creating positive public opinion. Crocodiles do not have the good looks and appeal of the elephant or tiger on their side but their presence on this earth for the past 200 million years, their ecological, touristic and their potential economic value as a resource can be conveyed to the public through mass media, the zoo and special publications.

The main current cause for crocodile decline in Sri Lanka is the depredation by fishermen for the meat which is dried and sold locally or sent to the larger fish markets and sold as crocodile (where in demand for purported "medicinal" value) or as dry shark (which it closely resembles). Several Karawa fishermen interviewed at somewhat remote tanks like Mahawilachchiya openly discussed their crocodile business. Even without the skins it is profitable for them; dried *Tilapia* and other fish sell for about Rs. 3/- per lb. whereas crocodile brings Rs. 4-5 per lb. It is a fairly simple and easy to conceal side business for the fishermen who have the equipment (nets) and who make regular rounds of even the most remote tanks during the dry season when fishing (and crodile catching) is easiest. The fishing permits are issued by the Executive Engineer, Irrigation and neither the Fisheries nor Wildlife Department are informed of these activities. These people plus a few isolated wealthy "sport" and skin hunters are the main direct sources of human pressure on crocodiles. Other killers of crocodiles are a number of specialized hunters who have learned the poachers' artful methods such as baited hooks (favourite baits being pups or monkey meat), night harpooning, noose trapping, removal from burrows and simple netting. One such hunter is old "Muthalay Peter" of Batticoloa. He was active back in the days of legalized skin dealing and at one time had 20 hunters working for him. Now he only kills the occasional crocodile which the Government Agent deems a nuisance crocodile in an inhabited area. Other important negative influences are the continued clearance of forest cover around tanks (which is so devastating to the land and all wildlife), and other large scale projects of "development".

Having identified the factors responsible for the decline of crocodiles and having acknowledged their value and usefulness it remains for these reptiles to be publicized and protected. Sri Lanka has much natural wealth to be proud of, not the least of which are its impressive crocodiles.

Based on observations, interviews and estimated carrying capacity of the areas surveyed the following estimates do not include first year hatchlings, numbers of which show great fluctuations due to high mortality

	Total	Breeding Females
C. palustris		
Ruhunu National Park (and periphery)	1000	100
Wilpattu National Park	800	75
North and North-Central	500	50
Rest of Country	500	50
Total	2800	275
C. porosus		
South-west coast	250	25
Rest of country	125	15
Total	375	40

SUMMARY OF SURVEY RESULTS (SRI LANKA)

No.	Date	Name of Tank, River, Lagoon etc.	District	Size	River Basin	Approximate crocodile population	*C. palustris* seen	Remarks.
1.	23-9-77	Giant's Tank	Mannar	5050 acres	Aruvi Aru	20-40	—	Fishermen & cowherders say crocodiles only on southern shore during these dry months and scatter to forest when tank completely dries. Good habitat within a sanctuary.
2.	23-9-77	Aruvi Aru (Madhu Road)	Mannar	10m. wide	Aruvi Aru	nil	—	Though reported to be common in the old literature, crocodiles are rarely heard about in this area now.
3.	24-9-77	Puttalam Lagoon	Pattalam	35km. long	—	nil	—	Crocodiles are no longer found here according to fishermen. Fishermen of these areas included crocodiles in their catches and dried the meat for sale.
4.	24-9-77	Mundal Lake	Pattalam	10km. long	—	nil	—	Crocodiles (probably *C. porosus*) seen in recent years in some of the inland swampy areas.
5.	1-10-77	Menik Ganga	Monaragala	20m. width 2m. depth	— —	0-2/km. in wild areas	2 adults	This river rarely dries up and has perennially deep pools which are extremely important crocodile refuges in drought years. There are numerous tunnels under tree roots in the banks adjacent to these pools. In 1974 we saw 16 adult crocodiles living in one of these pools near Kataragama. The two adults seen this trip were 100m from the main bathing ghat.
6.	1-10-77	Yoda Wewa	Hambantota	128 acres	Kirindi Oya	25-50	—	Western shore has some jungle —Rarely dries up completely.
7.	1-10-77	Debra Wewa	Hambantota	100 acres	Kirindi Oya	50+	3 adults	The perennial deep water is on the east bund where the crocodiles remain.
8.	1-10-77	Tissamaharama	Hambantota	706 acres	Kirindi Oya	50+	—	Perennial tank, famous for bathing. Baby crocodiles seen annually on small island eastern shore.

9.	1-10-77	Wira Wila	Hambantota		Kirindi Oya	25-50	18 most adults	Bordered by jungle on the west. Both this and the preceding tank lie within the 16 semi. Wirawila/Tissa Sanctuary (declared in 1938).
10.	2-10-77	Palatupana Lagoon	Hambantota	300m. x 100m.	—	12	1 adult, 10 hatchling	Just a few metres from the sea; water as salty as seawater. Crocodile tunnel and 2 week old young seen. On the border of Yala National Park.
11.	2-10-77	Palatupana Tank	Hambantota	500mx200m.	—	50+	35 50% adult	Though outside Yala Park receives full protection. Domestic buffalo and crocodiles share same mud flats.
12.	2-10-77	Hing Wewa	Hambantota	300x200m.	Menik Ganga	25-50	16 mainly adults	Within Yala, Hing is one of the last tanks to dry up. Ideal place for crocodile study in minimally modified habitat.
13.	2-10-77	Vikapalava Wewa	Hambantota	large, shallow	Menik Ganga	25-50	27 mainly adults	Many water birds, within Yala.
14.	2-10-77	Menik Ganga at Yala	Hambantota	60m. wide 1-2m. deep	Menik Ganga	1-5/km.	1 adult	This river is the main drought habitat in the whole western part of the Park.
15.	2-10-77	Rakinavala waterhole	Hambantota	100m diameter	—	1-2	1 subadult	This is one of the many water holes in Yala which contain 1 or 2 transient crocodiles.
16.	2-10-77	Palug Wala Wewa	Hambantota	50x50m.	—	3-5	3 adult	Small tank with transient crocodile population.
17.	2-10-77	Gonalubbe Lagoon	Hambantota	large	—	3	1 adult	Very close to the sea.
18.	1-10-77	Maynet Wewa	Hambantota	250x30m	Menik Ganga	10-12	2 adult	Crocodiles move from tank to tank in dry season finishing off the dying fish.
19.	2-10-77	Buttawa Wewa	,,	100x70m.	Menik Ganga	15-20	11, mainly adult	Very shallow tank, good fish population within Yala.
20.	2-10-77	Karangaswala, waterhole	,,	50x30m.	—	2-3	1 adult 3 hatchling	This waterhole is apparently occupied by no other crocodiles.
21.	2-10-77	Urniya Wewa	,,	50x30m.	—	5	4	2 adults, 2 subadults in this Yala pond.
22.	3-10-77	Godekalapuwa Lagoon	,,	large	—	20+	—	Located outside Yala fishermen regularly disturbed this lagoon.
23.	4-10-77	Palatupana Kalapuwa (Lagoon)	,,	medium	—	10-15	3	Salt concentrations become high enough to kill fish but crocodiles thrive here unaffected.

24.	4-10-77	Hungama Estuary	,,	small channels	Ranna River	unknown	—	Swamps of reeds and mangrove interspaced with paddy fields, good *C. porosus* area.
25.	4-10-77	Tangalle Swamp	,,	extensive area	Ranna River	few	—	Cane stands and reed beds with small channels. Crocodiles seen by fishermen.
26.	4-10-77	Mawella Kalapuwa	,,	medium	—	nil	—	Reed beds with small channels possible *C. porosus* area.
27.	4-10-77	Hamunagama Wewa	Matara	,,	—	nil	—	Fishermen report that crocodile population killed here 1974-75.
28.	4-10-77	Polatumothere Ganga (near Weligama)	,,	swamp channels	—	few *C. porosus*	—	Typical of the pockets of brackish *C. porosus* habitat left on the south west coast.
29.	4-10-77	Gin Ganga (near Gintota)	Galle	40m. wide	Gin Ganga	occasional *C. porosus*	—	Intricate network of channels and swampy areas. Old reports of nests. Permanent military establishment here now.
30.	5-10-77	Nilwala Ganga	Matara	30-50m. wide 2-5m. deep	Nilwala Ganga	formerly many, now few *C. porosus*	—	Small islands of excellent swampy habitat, inland surrounded by rice paddy.
31.	5-10-77	Bundala Estuary (Sanctuary)	Hambantota	large area	—	both *C. palustris* & *C. porosus* seen at high water	—	Mangrove, cane, palm, and hollie swamps interspaced with habitation and cultivation. Upriver pandanus and flag grass. Crocodiles move out of salt pans as they dry.
32.	5-10-77	Chandrika Wewa	Ratnapura	1100 acres	Walawe Ganga	10-20	—	Not known for large crocodile population.
33.	5-10-77	Walawe Ganga	Ratnapura & Monaragala	10-20m. wide	,,	few	—	Dries up in summer; a few crocodiles in tunnels.
34.	6-10-77	Uda Walawe Reservoir (National Park)	,,	8435 acres	,,	25-50	—	Very few crocodiles for this large tank. Much disturbance by fishermen at entry of river to reservoir.
35.	6-10-77	Kirindi Oya	Monaragala	10-20m. wide	Kirindi Oya	nill	—	*C. palustris* does not favour swift water but some permanent pools may contain a few specimens.
36.	6-10-77	Kuda Oya	,,	5-10m. wide	,,	,,	—	Appears to be adequate habitat to support "stream" crocodile population.

37.	6-10-77	Handapangala Wewa	,,	medium	,,	few	—	Crocodiles reportedly caught by fishermen during dry season with hooks or nets and the meat sold locally.
38.	6-10-77	Buttala Wewa	,,	large	Menik Ganga	,,	—	The upper Menik passes through wild habitat and there is probably a regular movement of crocodiles through this area.
39.	6-10-77	Lahugala Tank (Sanctuary)	Amparai	574 acres	Heda Oya	20-30 (seasonal)	tracks, feces	The lake was dry, the crocodiles apparently having gone overland to nearby pools in tributaries of the Heda Oya.
40.	7-10-77	Panama Tank	,,	308 acres	Wila Oya	100-200	72	This is one of the last tanks to dry up in this area, this seems to be the main reason for the concentration. Cultivation and some fishing is underway but the proximity of the game guards residence and the National Park protects this population, Annual.
41.	8-10-77	Radella Tank	,,	365 acres	Heda Oya	20-30	tracks	Almost dry now, its jungle location makes it very picturesque and excellent seasonal crocodile habitat.
42.	8-10-77	Naula Tank	,,	146 acres	Heda Oya		—	Shallow tank, dry now, crocodiles common when water is there.
43.	9-10-77	Senayanake Samudra	Monaragala	19,250 acres	Gal Oya	25-50	—	Crocodiles apparently only in Makara area.
44.	10-10-77	Jayanthi Wewa		large	Gal Oya	many	—	Large reservoir surrounded by rocky hills. Reportedly a large crocodile population but no evidence. Several fishermen report occasional crocodiles sighted. Perennial.
45.	10-10-77	Amparai Kulam	Amparai	896 acres	Gal Oya	nil	—	Salivina choked, crocodiles were known some years ago. Elephant come regularly to this tank; retaining its wildness would be most advantageous for Amparai residents. Perennial.

46.	10-10-77	Kondavatkavan Kulam	Amparai	879 acres	Gal Oya	6	—	Up to six crocodiles are seen regularly by residents and fishermen. Fair habitat heavy settlement. Perennial.
47.	10-10-77	Ekgal Aru Tank	Amparai	1015 acres	Gal Oya	25-50	tracks	Crocodiles, including young, are seen regularly by fishermen, rarely caught as they stay among tree stumps when fishermen are active.
48.	10-10-77	Irakkaman Kulam	Amparai	2030 acres	Gal Oya	few	—	Fishermen say very rarely are crocodiles seen as the tank is too shallow, heavily settled.
49.	11-10-77	Batticoloa Lagoon	Batticoloa	50km length	Gal Oya	few	—	*C. porosus* once very common here. With settlement and mangrove clearance crocodiles killed off and moved out. Still seen on mangrove island in northern part (Kankainadai lagoon).
50.	11-10-77	Rugam Tank	Batticoloa	2550 acres	Mundeni Aru	20-40	tracks, feces	Excellent crocodile habitat surrounded by jungle. Crocodiles concentrated at deep "modu" areas. Hunters from Rugam and Eravur come for crocodiles several times a year it is reported by Irrigation Board Staff. Perennial.
51.	11-10-77	Kitul Wewa	Batticoloa	531 acres	Mundeni Aru	25-50	—	Also surrounded by forest. Small area but good habitat and remote. Crocodiles have tunnels in banks. Annual.
52.	11-10-77	Chenkaladi Aar	Batticoloa	10m, wide	Chenkaladi	few seen regularly	—	Few tunnels in the area, river is perennial. Probably *C. palustris,* a few holding out in the denser swamps.
53.	12-10-77	Nelum Wewa	Polonnaruwa	10 acres	Mahaweli Ganga	2	—	2 crocodiles seen regularly in this small picturesque tank at the Milk Board. Elephants visit seasonally.
54.	12-10-77	Mahaweli Ganga	,,	30-50m. wide 25-30m. deep	Mahaweli Ganga	few seen in scattered localities	—	There is plenty of good wild habitat along this river. Crocodiles seen at river junctions (Amban Ganga) and deep river beds; usually one or two. Down river the more remote Sanctuary may have a better population.

55.	12-10-77	Parakrama Samudra	,,	6250 acres	Mahaweli Ganga	10-20	—	Crocodiles seen by fishermen where Amban Ganga enters. Area bordered by some good forest.
56.	12-10-77	Minneriya Tank	,,	6300 acres	Mahaweli Ganga	10-20	—	Crocodiles rarely seen though habitat appears suitable. Sanctuary and Biosphere Reserve area; formerly had good crocodile population.
57.	12-10-77	Thenadhra Tank (Habarana)	,,	small	—	few	—	Lotus filled, crocodiles seen seasonally in this and nearby small tanks.
58.	13-10-77	Kalunkerny Kulam (Mullaitivu)	Vavuniya	medium	—	10-20	8	This is a small tank but usually has enough water for the crocodiles. Young also seen by fishermen. Tank surrounded by grazing land and cultivation, very little forest.
59.	13-10-77	Nanthi Kadal Lagoon	,,	20 km. long	—	nil	—	This shallow lagoon has no mangrove and dries up in summer. Crocodiles have been seen in transit during high water.
60.	14-10-77	Mamaduwa Tank	,,	592 acres	Parangi Aru	20-40	2	This tank is surrounded mainly by forest and is excellent crocodile habitat.
61.	14-10-77	Iranaimadu Tank	Vavuniya	medium	—	10-20	3	Few seen by fishermen though habitat appears excellent with considerable forest surrounding. This and Kokkavi tank usually have water when other tanks dry out.
62.	15-10-77	Jaffna Lagoon	Jaffna	40 km long	—	nil	—	Though reported in old literature crocodiles seem to have become extinct in this area since several decades. Chundikkulam Sanctuary has occasional crocodiles, probably *C. palustris* from the tanks (Iranaimadu etc.).
63.	16-10-77	Mahakandarawa Tank	Anuradhapura	3600 acres	Aruvi Aru	20-40	17	Good habitat with nesting areas, forest. Young seen by fishermen Perennial; located in Mihintale Sanctuary.

64.	16-10-77	Rajangana Reservoir	,,	3950 acres	Kala Oya	20-40	4		Large fishing industry here. Crocodiles occasionally caught in nets. Also seen in Kala Oya below dam. Mostly settled area.
65.	16-10-77	Tissa Wewa	,,	460 acres	Aruvi Aru	nil		—	Before the recent drought several crocodiles were still seen.
	16-10-77	Basawak Kulam	,,	265 acres		,,		—	
	16-10-77	Nuwara Wewa	,,	2956 acres		,,		—	Traditionally a crocodile haunt.
66.	17-10-77	Pusiam Kulam	,,	small	—	5		—	Up of 5 crocodiles seen every year except drought years in this pond on the Mahawilachiya Road.
67.	17-10-77	Mahawilachchiya	,,	2400 acres	Moderagam Aru	50-100	7		Fishermen report many crocodiles here but very shy because of heavy fishing and incidental crocodile catching. Good habitat on edge of Wilpattu National Park. Crocodiles also seen in Talava Oya below bund; heavy forest.
68.	26-10-77	Bogoda Lake (Virahera)	Colombe	large area	—	several reported		—	Nests of *C. porosus* reported in recent years in this dense marsh land. Babies caught in fish traps, crocodiles occasionally hunted at night or baited hooks set.
69.	27-10-77	Chilaw/ Kurunegala Road	Kurunegala	large area	—	nil		—	Much swampy habitat with former crocodile population. Settlement and cultivation has replaced most optimum habitat.
70.	29-10-77	Parana Ela (Wattala)	Colombo	10m. wide canals	Kelani Ganga	several reported		—	Seasonal movement of a few *C. porosus*. One $2\frac{1}{2}$m. crocodile in residence, swampy areas in the midst of factory and residential developments. The Muthurajavela swampland between Negombo and Colombo is the main "recruitment" area for *C. porosus* here.

71.	22-10-77	Attanagalu Oya (Gampaha)	,,	5m. wide	—	4	tracks	Several tunnels in sides of this stream. Fishermen report occasionally sighting crocodiles here. Young *C. porosus* and *C. palustris* have been caught in this area.
72.	23-10-77	Negombo lagoon	Colombo	15km. long	—	few	—	Residents and fishermen state that few crocodiles are seen any more, but that in parts of the dense inland swamp nesting still occurs.

SUMMARY OF E. WEDANDA'S RESULTS

1.	3-10-77	Kaluganga River	Kulutara	20-40m. wide	Kalug-anga	several reported	—	Crocodiles formerly plentiful according to fishermen and river sand workers. Areas where they still can be seen (*C. porosus*) at Kohotana (down river) 10 Kms. and Gonaduma on the Piliyandala Road.
2.	3-10-77	Benthara River	Galle	—	10-20 m. wide	few	—	Crocodiles (*C. porosus*) scarce but occasionally seen at Avithathana.
3.	3-10-77	Dedhduwa River	Galle	10m. wide	—	few	—	Small crocodiles seen in fish traps. Larger crocodiles occasionally seen in swamp several miles from Alutgama on the Elipitiya Road.
4.	3-10-77	Madampa River (Ambalangada)	,,	10m. wide	—	,,	—	Fishermen report seeing young crocodiles and rarely an adult these days. A branch of this river, Batapola Ela, is also reported to have some crocodiles left. People along the Karadeniya River (a branch of the Madampa) are reportedly fond of catching and eating crocodiles.
5.	4-10-77	Hikkaduwa Lake	,,	medium	—	,,	—	Fishermen and residents report occasional crocodile sightings. One (3m.) reported killed recently which had caught many dogs (Kotiduwa).
6.	4-10-77	Gin Ganga (Ginthota)	,,	10-15m. wide	—	nil	—	Though crocodiles formerly here, now absent since the establishment of the Plywood Corporation mill.

7.	5-10-77	Nilwala Ganga (Matara)	Matara	30-40m. wide	Nilwala Ganga	several	—	At Kapuwa Ela, a branch of the Nilwala Ganga up to 6 crocodiles have been seen recently and nests in the past. Here there is a well known crocodile hunter.
8.	5-10-77	Tangalla	Hambantota	—	—	few	—	Crocodiles rarely seen now but now and then in the river after heavy rains.
9.	6-10-77	Walawe Ganga (Ambalantota)	,,	30-40m.	Walawe Ganga	,,	—	Crocodiles very rare now, seen few miles up river on occasion. At Godawaya is a place called "Kimbulkatte" (crocodile's mouth) which has mangrove and a few crocodiles are still reported here. Crocodile reportedly shot recently by police constable.
10.	6-10-77	Ridiyagama Tank	,,	2195 acres	Walawe Ganga	50-100	—	Young crocodiles caught recently by fishermen. Tank said to still have a fair population.
11.	8-10-77	Thamara Kulam	Amparai	small	—	nil	—	Dry now, the small tank generally has a small crocodile population even though located on the edge of Pottuvilp town. Also at Rottai Kulam nearby.
12.	8-10-77	Semmani Kulam	,,	medium	—	10-20	tracks, feces	This is one of the last tanks in the Pottvilp area to dry up. Aparently crocodiles from small tanks come here.
13.	8-10-77	Panama Lagoon Arugam Bay Lagoon	,,	,,	—	few	1	Crocodiles move seasonally in and out of these lagoons. *C. porosus* appears to be quite rare; *C. palustris* apparently uses the lagoons to tide over the drought period.
14.	9-10-77	Landandara stream (Pottuvilp)	,,	small	—	2	1	Though a very small stream the pools support a small crocodile population which have tunnels under over hanging tree roots.

15.	9-10-77	Sakamam Sanctuary	,,	medium	—	few	1	These lagoon areas have little suitable habitat left. Observed one crocodile by night on small river near coast here.
16.	9-10-77	Ooraniya Oya (Kalmunai)	,,	small	—	,,	tracks	A few crocodiles remain in the pools and streams of this area.
17.	11-10-77	Kantalai Reservoir	Trinco-malee	5850 acres	Mahaweli	10-20	—	Fishermen report that crocodile population much lower than formerly. Few crocodiles seen recently. Nesting observed in the north and west parts of the tank. In Kuda Wewa, adjoining Kantalai, a few crocodiles reported; also nearby Mora Wewa and Vadasen tank.
18.	11-10-77	Paravipanjam Kulam	,,	medium	,,	over 50	tracks	Crocodile reported recently killed here. Good habitat in these areas, forest etc. Well organized hunters visit annually it is reported here.
19.	12-10-77	Periya Kulam	,,	275 acres	Panna Oya	10	—	Several crocodiles caught here in past few years, a few can be seen regularly basking. Jungle area, good possible crocodile reserve.
20.	13-10-77	Irrakkakandi Lagoon	,,	10 kms. long	—	several	—	Crocodiles seen fairly regularly by fishermen. Plenty of mangrove and other suitable habitat. Probably a *C. porosus* population.
21.	13-10-77	Trinco Lagoon	,,	large	—	few	—	A large crocodile was reported seen recently in local newspapers. The formerly reported abundance of crocodiles is much changed now.
22.	13-10-77	Samara Kulam	,,	medium	—	50-100	—	This is a wild area with good, intact forest. Fishermen report very little hunting of crocodiles here so there is still good population.

23.	13-10-77	Salpai Aru	,,	small	—	50-100	—	Fishermen see crocodiles fairly regularly near mangroves, particularly at night. Crocodiles caught here for drying the flesh by fishermen. More are seen in the interior during the rainy months.
24.	13-10-77	Periya Villu (Kuchchaveli)	,,	medium	—	few	—	Up to 10 large crocodiles seen here regularly, young also seen. Stream Vaval Oday has a few crocodiles.
25.	13-10-77	Niela Panikkam Kulam (Tiriyai)	,,	,,	Yan Oya	many	—	This lagoon is one which has water for most of the year. Crocodiles are seen regularly and fishermen feel that they have tunnels in the extensive mangroves. During the drought periods many crocodiles killed here and turned into "dry fish."
26.	13-10-77	Yan Oya	,,	small	,,	several	—	Fishermen report that several miles upriver in the interior many crocodiles can still be seen, tunnels in river bank etc.
27.	14-10-77	Padawiya Tank	Anuradha-pura	6480 acres	Ma Oya	50-100	—	According to Irrigation Department staff and fishermen crocodile population is stable or increasing here. Little or no killing of crocodiles. The Wan Ela canal from the tank has deep areas in which crocodiles live, burrow into banks etc. Young crocodiles seen recently.

Summary of Results etc.

Introduction :

In the brief period spent on this survey a representative coverage was made of crocodile habitat in Sri Lanka. A cumulative 5,000 kms. was covered by the survey team and total of 300 crocodiles observed. In the wild and semi wild habitat of this small island live more wild crocodiles than on the entire Indian mainland.

The populations of *C. palustris* within the two largest National Parks will apparently withstand Sri Lanka's rapid development (settlement, plantation, deforestation, dams etc.) but unless the ecological and economic value of these reptiles is recognized they will soon be exterminated in the rest of the country. Inland fisheries in general and the itinerant fishermen in particular stand to benefit greatly if the crocodile resource is allowed to remain through wise management. Cropping, quotas, size limits to protect the breeders and publicity to gain sympathy and tolerance for crocodiles will help ensure their perpetuation.

The saltwater crocodile has much less chance of survival and as already mentioned its fate is dependent on the identification of a suitable area as a preserve. As it has the most valuable skin of any crocodilian in the world, important consideration should be given to both captive and wild propogation for economic return to hunting and fishing people of the lower income brackets.

ACKNOWLEDGEMENTS

We are grateful to the Wildlife and Nature Protection Society, Ceylon and Madras Snake Park Trust for funding this survey. Several District Representatives of Wildlife and Nature Protection Society were extremely helpful. The Wildlife Department was most helpful and co-operative. Thanks to Mr. and Mrs. Ranil Senanayake for their help and hospitality. We are also grateful for the help received by Ernest Wedanda who accompanied us for part of the survey and carried out independent survey work for us. Dr. P. H. D. H. de Silva helped with a bibliography of Crocodile references.

REFERENCES

BAKER, S. W. (1855): Eight years in Ceylon. London.

BALDAEUS, P. (1671): A description of the Empire of Ceylon.

CAVE, H. W. (1900): Ruined cities of Ceylon. London.

CLARK, A. (1901): Sport in the low Country of Ceylon. Colombo.

COTT, H. B. (1961): Scientific results of an inquiry into the ecology and economy status of the Nile Crocodile (*Crocodilus nilotica*) in Uganda and Northern Rhodesia. *Trans. Zool. Soc. Lond.* *29*: 211-356.

DAVY, J. (1821): An account of Ceylon. London.

DERANIYAGALA, P. E. P. (1930): Crocodiles of Ceylon. *Spolia Zeylanica* Vol. XVI.

——————— (1939): Tetrapod Reptiles of Ceylon. Colombo Museum.

FALCK (1767): Travels in Ceylon.

FERGUSON, W. (1877): Reptile Fauna. Ceylon, Govt. Printers, Colombo.

FITTKAU, E. J. (1970): Role of Caimans in the Nutrient Regime of mouth-lakes of Amazon Affluents. *Biotropica* *2*(2).

——————— (1973): Crocodiles and the nutrient metabolism of Amazonian waters. *Amazoniana* *4* (1): 103-133.

HENNESSY, D. J. G. (1949): Green Aisles. Colombo.

HEYDT, J. W. (1744): Heydt's Ceylon. Ceylon Govt. (reprint 1952).

SOMANADER, S. V. (1941): The Swamp Crocodile. *Loris,* Vol. 12.

SPITTEL, R. L (1924): Wild Ceylon.

STOREY, H. (1907): Hunting and Shooting in Ceylon. Longmans, London.

TENNENT, J. E. (1859): Ceylon. Longmans, London.

WARD, H. (1859): *In*: R. L. Bothier's Ancient Irrigation works in Ceylon. Govt. Press, Ceylon.

A PROVISIONAL, ANNOTATED CHECK-LIST OF THE FRESHWATER FISHES OF IRAN[1]

BRIAN W. COAD[2]

(*With a text-figure*)

INTRODUCTION

The purpose of this paper is to provide a list of Iranian freshwater fishes in order to facilitate further studies on this fauna by interested students. Its provisional nature is occasioned by the poor state of present knowledge on the systematics of Iranian fishes. Many species are still known only from their original, brief descriptions, based on a few specimens, and published in a variety of journals and books, some of which are not readily available, particularly to local ichthyologists. There appears to be much synonymy in these descriptions and wherever possible the validity of species is commented on.

Several drainages cross the borders of Iran and have either their headwaters or lower reaches in Iran. In addition certain rivers form the border of Iran. Some fishes recorded from these drainages are included in the check-list but this cannot be an exhaustive listing because distributional data within river systems is scanty or absent and headwaters in Iran cannot be assumed to have the same species as the main river in its lower reaches. The principal border drainages of Iran are the lower Araks or Araxes River in north-west Iran on the border of the Azerbaijan SSR and the Armenian SSR (but not Lake Sevan); the upper reaches of the Tigris River tributaries, principally the Diyala and Lesser Zab Rivers, on the Iraq border; the lower Shatt-el-Arab (confluence of the lower Tigris and Euphrates River forming part of the Iraq-Iran border); the Mashkel, Nihing, Nahang and Tahlab Rivers which cross or form part of the border between Iranian and Pakistani Baluchistan; the rivers which flow from Afghanistan into the Seistan endorheic drainage basin which lies partly in Iran, principally the Helmand River but also the Shelagh, Dor, Khash, Khouspas, Farah and Herat Rivers; the Hari and Tedzhen Rivers forming part of the north-eastern borders of Iran with Afghanistan and the Turkmen SSR (or Turkmenistan); and the Atrek River forming part of the northern border of Iran with the Turkmen SSR, east of the Caspian Sea.

The Caspian Sea is treated here as freshwater although its salinity is about 1.2-1.3%. (Zenkevitch 1963). Several species are recorded by Berg (1949a) from the northern part of the Caspian Sea and its tributaries but these are not included here.

Certain marine fishes from the Persian Gulf and Sea of Oman are known to enter freshwater in other parts of their range but the majority of these are not listed here in the absence of definite records. A check-list

[1] Accepted. May 1978.

[2] Department of Biology, Pahlavi University, Shiraz, Iran. *Present address*: Ichthyology Section, National Museum of Natural Sciences, Ottawa, Ontario, Canada K1A 0M8.

of Persian Gulf and Sea of Oman fishes is in preparation.

The arrangement of orders and families follows Nelson (1976), a recent, summary review of fish classification. Species are listed alphabetically under each family.

Check-list

CLASS 1. CEPHALASPIDOMORPHI

ORDER 1. Petromyzoniformes

FAMILY 1. PETROMYZONIDAE

1. *Caspiomyzon wagneri* (Kessler, 1870), Endemic to the Caspian Sea and its tributaries (Berg 1949a).

CLASS 2. CHONDRICHTHYES

ORDER 2. Lamniformes

FAMILY 2. CARCHARHINIDAE

A shark has been recorded as entering the Shatt-el-Arab and the Karun River as far as Ahwaz (Hunt 1951). Its identity has not been confirmed but Khalaf (1961) and Mahdi (no date) list *Carcharhinus gangeticus* (Muller and Henle, 1841) and *C. lamia* (Blainville, 1820) from the Tigris River at Baghdad and *C. menisorrah* (Muller and Henle, 1841) from the Shatt-el-Arab and the Tigris River. The specific validity of some of these large sharks is disputed (Kuronuma and Abe 1972).

CLASS 3. OSTEICHTHYES

ORDER 3. Acipenseriformes

FAMILY 3. ACIPENSERIDAE

1. *Acipenser güldenstädti* Brandt, 1833. South Caspian Sea and tributary rivers (Berg 1948).
2. *Acipenser nudiventris* Lovetzky, 1828. Sefid River and Caspian Sea (Berg 1948).
3. *Acipenser persicus* Borodin, 1897. South Caspian Sea and tributary rivers. Regarded as a subspecies of a *A. güldenstädti* by some authors (e.g. Berg 1948) but as a distinct species by Borodin (1926).
4. *Acipenser stellatus* Pallas, 1771. Sefid River and South Caspian Sea as *A. s. stellatus* natio *cyrensis* Berg, 1932 (Berg 1948).
5. *Huso huso* (Linnaeus, 1758). Sefid River, Atrek River, Gorgan and Caspian Sea (Berg 1948). *H. h. caspicus* Babushkin, 1942 is the subspecies of Caspian drainages (Ladiges 1964).

ORDER 4. Clupeiformes

FAMILY 4. CLUPEIDAE

1. *Alosa brashnikovi* (Borodin, 1904). South Caspian Sea with eight subspecies listed by Berg (1948) and Svetovidov (1945b; 1952) as *agrachanica* (Mikhaylovsky, 1941), *autumnalis* (Berg, 1915), *brashnikovi* (Borodin, 1904), *grimmi* (Borodin, 1904), *kisselewitschi* (Bulgakov, 1926), *nirchi* (Morosov, 1928), *orientalis* (Mikhaylovsky, 1941) and *sarensis* (Mikhaylovsky, 1941).
2. *Alosa caspia* (Eichwald, 1838). *A. c. caspia* (Eichwald, 1838) is found throughout the Caspian Sea, *A. c. knipowitschi* Iljin, 1927) is found in the southwestern Caspian Sea with natio *knipowitschi* (Iljin, 1927) in Iranian waters and natio *saraica* (Berg, 1948) near the northwestern border of Iran at Astara, and *A. c. persica* (Iljin, 1927) is found in the southeastern Caspian Sea.
3. *Alosa curensis* (Suvorov, 1904). Caspian Sea near the mouth of the Kura River, close to Iranian waters (Berg 1948). May be a synonym of *A. brashnikovi* (Svetovidov 1945b; 1952).

4. *Alosa kessleri* (Grimm, 1887). South Caspian Sea in winter as *A. k. kessleri* (Grimm, 1887) and *A. k. volgensis* (Berg, 1913) (Svetovidov 1952).
5. *Alosa saposhnikovii* (Grimm, 1887). South Caspian Sea in cold winters (Berg 1948; Svetovidov 1952).
6. *Clupeonella delicatula* (Nordmann, 1840). South Caspian Sea (Berg 1948) as *C. d. caspia* Svetovidov, 1945 (Svetovidov 1945a; 1952).
7. *Clupeonella engrauliformis* (Borodin, 1904). South Caspian Sea (Berg 1948; Svetovidov 1952).
8. *Clupeonella grimmi* Kessler, 1877. South Caspian Sea (Berg 1948; Svetovidov 1952).
9. *Hisla ilisha* (Hamilton-Buchanan, 1822). Recorded from the Tigris River at Baghdad, Euphrates River and Shatt-el-Arab (Khalaf 1961; Mahdi, no date).

ORDER 5. Salmoniformes

FAMILY 5. Esocidae

1. *Esox lucius* Linnaeus, 1758. Caspian Sea and tributaries (Berg 1948). This sport fish is being transplanted outside its natural distribution by the Department of the Environment.

FAMILY 6. Salmonidae

1. *Salmo gairdneri* Richardson, 1836. Caspian Sea coast and tributaries and other suitable localities throughout Iran. An introduced sport fish being actively transplanted by the Department of the Environment.
2. *Salmo trutta* Linnaeus, 1758. Reported from Caspian Sea tributaries, Lake Reza'iyeh basin, Azerbaijan, and the Karadj River in the Darya-e-Nemak basin. *S. t. caspius* Kessler, 1877 is the subspecies from the Sefid River, Mazanderan and Azerbaijan rivers (Berg 1948). *S. t. macrostigma* (Dumeril, 1858) (in Berg 1948; 1949b) is found near Tehran from the Karadj River. A population differing from the European brown trout is found in the Lighvanchai River of the Lake Reza'iyeh basin. Its specific or subspecific status is not known.

ORDER 6. Cypriniformes

FAMILY 7. Cyprinidae

1. *Abramis brama* (Linnaeus, 1758). As *A. b. orientalis* Berg, 1949 from south Caspian Sea rivers (Berg 1949a).
2. *Abramis sapa* (Pallas, 1811). As *A. s. bergi* Belyaev, 1929 from south and central Caspian Sea entering all rivers (Berg 1949a).
3. *Acanthobrama centisquama* Heckel, 1843. Iraq (Mahdi and Georg 1969), not reported from Iran.
4. *Acanthobrama marmid* Heckel, 1843. Tigris and Euphrates Rivers. Synonyms are *A. arrhada* Heckel, 1843 and *A. cupida* Heckel, 1843 (Berg 1949b; Ladiges 1960). Not reported from Iran.
5. *Acanthalburnus microlepis* (Filippi, 1863). Araxes River basin. *A. punctulatus* (Kessler, 1877) is a synonym (Berg 1949a).
6. *Alburnoides bipunctatus* (Bloch, 1782). As *A. b. eichwaldi* (Filippi, 1863) from south Caspian Sea rivers, Karadj River and Lake Reza'iyeh basin (Berg 1949b). Also reported from the Anatolian Euphrates River drainage (Kosswig 1955).
7. *Alburnoides urmianus* (Gunther, 1899). Basin of Lake Reza'iyeh (Gunther 1899).
8. *Alburnoides* n. sp.? (Coad, MS). Pulvar River drainage, Fars.

9. *Alburnus atropatenae* Berg, 1925. Lake Reza'iyeh basin (Berg 1925; Vladykov 1964).
10. *Alburnus caeruleus* Heckel, 1843. Sarchenar stream, Hor Abou-Nedjin, Iraq. Not reported from Iran (Misra 1947; Khalaf 1961; Mahdi and Georg 1969).
11. *Alburnus caudimacula* Heckel, 1846. Kara-Agatsch (=Mand) River in Fars (Ladiges 1960).
12. *Alburnus charusini* Herzenstein, 1889. Reported from the Araxes River by Berg (1949a) as *A. c. hohenackeri* Kessler, 1877 and from the Sefid River as *A. c. h.* natio *persicus* Petrov, 1926. *Alburnus pseudospirlinus* Petrov, 1926 is a hybrid between the latter and *Alburnoides bipunctatus eichwaldi* (Filippi) (Berg 1949a).
13. *Alburnus doriae* Filippi, 1862. Described from Shiraz (Berg 1949b).
14. *Alburnus filippi* Kessler, 1877. Sefid River and Lake Reza'iyeh basin (Gunther 1899; Berg 1949a).
15. *Alburnus iblis* Heckel, 1846. "Araxes River" or neighbourhood of Persepolis (Heckel 1846). This is not the Araxes River on the USSR border but the Kor River, Fars. May be a synonym of *Chalcalburnus mossulensis* (Heckel, 1843) (Berg 1949b).
16. *Alburnus maculatus* Keyserling, 1861. Neighbourhood of Isfahan (Keyserling 1861). Berg (1949b) considers that it is possibly identical with *Alburnus doriae. Alburnus maculatus* Kessler, 1859 is a senior homonym, placed in the synonymy of *Alburnoides bipunctatus fasciatus* (Nordmann, 1840) by Berg (1949a).
17. *Alburnus megacephalus* Heckel, 1846. Araxes River (=Kor River in Fars) (Heckel 1846). May be a synonym of *Chalcalburnus mossulensis* (Heckel, 1843) (Berg 1949b).
18. *Alburnus orontis* Sauvage, 1884. Reported from Iraq (Mahdi and Georg 1969) and Caspian Sea drainages of Iran (Armantrout 1969).
19. *Alburnus pallidus* Heckel, 1843. Recorded from Iraq (Mahdi and Georg 1969). Not reported from Iran.
20. *Alburnus schejtan* Heckel, 1846. Araxes River (=Kor River in Fars) and Tigris River (Heckel 1846; Misra 1947). May be a synonym of *Chalcalburnus mossulensis* (Heckel, 1843) (Misra 1947; Berg 1949b).
21. *Alburnus striatus* Petrov, 1926. Kizilagach and Astrabad bays, Caspian Sea. Very close to *Alburnus charusini hohenackeri* Kessler (Berg 1949a).
22. *Aspidoparia morar* (Hamilton-Buchanan, 1822). Eastern Iran, Mashkel River drainage (Mirza 1975).
23. *Aspius aspius* (Linnaeus, 1758). South Caspian Sea rivers as *A. a. taeniatus* Eichwald, 1831 (Berg 1949a; Svetovidov 1945b).
24. *Aspius vorax* Heckel, 1843. Tigris and Euphrates Rivers (Khalaf 1961; Ladiges 1960) and upper reaches of Karkheh River system in Iran (Armantrout 1969).
25. *Barbus belayewi* Menon, 1956. Tigris River, not reported from Iran (Khalaf 1961).
26. *Barbus brachycephalus* Kessler, 1872. As *B. brachycephalus caspius* Berg, 1914 from south Caspian Sea rivers (Berg 1949a).
27. *Barbus capito* (Güldenstädt, 1773). As *B. c. capito* (Güldenstädt, 1773) in south Caspian Sea rivers, both resident and anadromous (Berg 1949a), probably also Tigris-Euphrates system (Karaman 1971).

Synonyms include *Cyprinus bulatmai* Hablizl, 1783, *Cyprinus chalybatus* Pallas, 1811, *Barbus bilkewitschi* Bulgakov, 1923, *B. capito serratus* Solinskii, 1927, *B. conocephalus* Kessler, 1872 and *B. lacertoides* Kessler, 1872 (Karaman 1971). The subspecies *B. c. pectoralis* Heckel, 1843 has *B. kersin* Heckel, 1843 as a synonym (Karaman 1971) and the latter is recorded from Tigris River tributaries by Khalaf (1961). Berg (1949b) regards *B. kersin* as a distinct species.

28. *Barbus esocinus* (Heckel, 1843). Tigris and Euphrates Rivers, mainly upstream in Iraq (Khalaf 1961) and the Diyala River (Mahdi, no date). Not reported from Iran. *Labeobarbus euphrati* Sauvage, 1882 is a synonym (Karaman 1971).
29. *Barbus mursa* (Güldenstädt, 1773). Karaman (1971) divides this species into two subspecies, *B. m. mursa* (Güldenstädt, 1773) from the Sefid and Araxes Rivers (Berg 1949a) and *B. m. miliaris* Filippi, 1862 from a Tehran spring and Karadj River system (Vladykov 1964). *B. mursoides* Kessler, 1877, *B. miliaris* Filippi, 1862 and *B. kessleri* Derjavin, 1929 are synonyms. Berg (1949b) synonymises *B. kessleri* with *B. miliaris* which is regarded as a valid species.
30. *Barbus plebejus* Bonaparte, 1832. Karaman (1971) lists fourteen subspecies including *B. p. lacerta* Heckel, 1843 from the Araxes River, south Caspian Sea rivers and Tigris-Euphrates system. Synonyms include *Barbus lacerta* Heckel, 1843, *B. scincus* Heckel, 1843, *B. cyri* Filippi, 1865, *B. caucasicus* Kessler, 1877, *B. toporovanicus* Kamenskii, 1899, *B. bortschalinicus* Kamenskii, 1899, *B. sursunicus* Kamenskii, 1899, *B. armenicus* Kamenskii, 1899, and *B. angustatus* Kamenskii, 1899. Additional records for this species based on synonymised species include the Karun River, Lake Reza'iyeh basin and the upper reaches of the Tigris River on the Iranian border (Gunther 1899; Berg 1949b; Vladykov 1964; Armantrout 1969). Berg (1949a; 1949b) considered *B. lacerta* to be a valid species, divided into *B. l. cyri* Filippi, 1865 with *B. caucasicus, B. toporovanicus, B. bortschalinicus, B. sursunicus, B. armenicus,* and *B. angustatus* as synonyms, and *B. l. lacerta* Heckel, 1843 with *B. scincus* as a synonym.
31. *Barbus rajanorum* Heckel, 1843. Karaman (1971) cites two subspecies with *B. r. mystaceus* Heckel, 1843 reported from the Karun River and upper reaches of the Karkheh River system (Armantrout 1969). *Luciobarbus schejch* Heckel, 1843 is a synonym (Berg 1949b; Karaman 1971). *Barbus barbulus* Heckel, 1846 is synonymised with the type subspecies by Karaman (1971) but recognised as a distinct species by Berg (1949b). It is found in the Kara-Agatsch (=Mand) and Tigris Rivers. *Luciobarbus mystaceus* Heckel, 1843 is placed in *B. rajanorum* by Berg (1949b) but in *B. xanthopterus* (Heckel, 1843) by Misra (1947).
32. *Barbus xanthopterus* (Heckel, 1843). Shatt-el-Arab, Tigris, Buphrates, Karun and Karkheh Rivers (Khalaf 1961; Karaman 1971; Svetovidov 1949).
33. *Barilius mesopotamicus* Berg, 1932. Tigris River basin in Iran at 33° 20′N, 46° 20′E and 33° 42′N (Berg 1932; 1949b).
34. *Bertinius longiceps* (Valenciennes, 1842). As *B. l. persicus* Karaman, 1971 in the Karun River (Karaman 1971).
35. *Bertinius subquincunciatus* (Gunther, 1868). Tigris-Euphrates system and Kar-

kheh River system in Iran (Karaman 1971).

36. *Blicca bjoerkna* (Linnaeus, 1758). As *B. bjoerkna transcaucasica* Berg, 1916 in south Caspian Sea rivers (Berg 1949a).
37. *Capoeta barroisi* (Lortet, 1894). As *C. b. persica* Karaman, 1969 from 120 Km. west of Sanandaj (Karaman 1969).
38. *Capoeta buhsei* Kessler, 1877. Tehran (? Karadj River system), Lake Reza'iyeh basin and the Sefid River (Vladykov 1964; Armantrout 1969; Karaman 1969). *Varicorhinus nikolskii* Derjavin, 1929 is a synonym (Karaman 1969).
39. *Capoeta capoeta* (Güldenstädt, 1773). Karaman (1969) describes eleven subspecies including *C. c. aculeatus* (Valenciennes, 1844) from Tehran (probably the Karadj River system) (synonym *Varicorhinus bergi* Derjavin, 1929 from the Karadj River system), *C. c. capoeta* (Güldenstädt, 1773) from the Araxes River, *C. c. damascinus* (Valenciennes, 1842) from the upper Euphrates River in Iraq, *C. c. gracilis* (Keyserling, 1861) from south Caspian Sea rivers, Lake Reza'iyeh basin and vicinity of Isfahan (Gunther 1899; Berg 1949a; 1949b; Svetovidov 1949) (synonym *C. gibbosa* Nikolsky, 1897 from eastern Iran and southeast Khorassan (Berg 1949b; Armantrout 1969), *C. c. heratensis* (Keyserling, 1861) from the Tedzhen River [synonyms *Scaphiodon asmussi* Keyserling, 1861 from the Hari River and *C. steindachneri* Kessler, 1872 from N. W. Afghanistan), *C. c. macrolepis* (Heckel, 1846) from Shiraz, Persepolis, Isfahan and upper Karkheh River drainages (Armantrout 1969) (synonyms *Scaphiodon chebisiensis* Keyserling, 1861 from Kerman and Shiraz (Tortonese 1934) and *Scaphiodon rostratus* Keyserling, 1861 from Yazd], and *C. c. umbla* (Heckel, 1843) from the upper Tigris-Euphrates system [synonyms possibly *Scaphiodon amir* Heckel, 1846 from Shiraz and Kerman (Nikolsky 1899), *Scaphiodon niger* Heckel, 1846 from Shiraz, and *Scaphiodon saadii* Heckel, 1846 from Persepolis and Shiraz (Heckel 1846)].
40. *Capoeta fusca* Nikolsky, 1897. Kerman, southern Khorassan. *C. nudiventris* Nikolsky, 1897 is a synonym (Karaman 1969).
41. *Capoeta trutta* (Heckel, 1843). Tigris, Karun, and Karkheh River systems (Karaman 1969).
42. *Carasobarbus luteus* (Heckel, 1843). Tigris, Euphrates, Diyala, Karun, and Karkheh River basins, Shiraz, Kara-Agatsch (=Mand) River, Lake Famur (Karaman 1971; personal collections). Synonyms include *Systomus albus* Heckel, 1843, *Barynotus luteus* Gunther, 1874 and *Systomus luteus* Heckel, 1843.
43. *Carassius auratus* (Linnaeus, 1758). Introduced species, found throughout Iran.
44. *Chalcalburnus chalcoides* (Güldenstädt, 1772). As *C. chalcoides iranicus* Svetovidov, 1945 reported from the Caspian Sea, entering Iranian rivers (Svetovidov 1945a).
45. *Chalcalburnus mossulensis* (Heckel, 1843). Found in south Caspian Sea rivers(?), the Tigris-Euphrates drainage including the Kurdistan region of Iran and the Diyala River, and drainages of Fars (Berg 1949b; Armantrout 1969; personal collections). Synonyms are *Alburnus capito* Heckel, 1843 and *Leuciscus maxillaris* Cuvier and Valenciennes, 1844 and possibly *Alburnus iblis* Heckel, 1846, *A. megacephalus* Heckel, 1846 and

A. schejtan Heckel, 1846 (Berg 1949b).

46. *Chalcalburnus sellal* (Heckel, 1843). Reported from the Kura(?) and Euphrates River drainages (Ladiges 1960). Not recorded from Iran. Synonyms are *Alburnus microlepis* Heckel, 1843 and *Alburnus hebes* Heckel, 1843 (Berg 1949b).
47. *Chondrostoma cyri* Kessler, 1877. Araxes River where also recorded as *C. cyri leptosoma* Berg, 1914 (Berg 1949a).
48. *Chondrostoma nasus* (Linnaeus, 1758). Reported from Iraq by Mahdi and Georg (1969). Not recorded from Iran.
49. *Chondrostoma regium* (Heckel, 1843). Tigris and Euprates Rivers, Diyala River, upper reaches of Karkheh River in Iran (Berg 1949b; Mahdi, no date; Armantrout 1969).
50. *Crossochilus adiscus* (Annandale, 1919). Described from Seistan (Berg 1949b). Menon (1964) notes its close resemblance to *C. diplochilus* (Heckel, 1838) from Kashmir (see below). Karaman (1971) considers it to be in the genus *Hemigarra* as *H. elegans adiscus* Annandale, 1919.
51. *Crossochilus latius diplochilus* (Heckel, 1838). Reported from Iranian Baluchistan and the Mashkel River drainage as well as Kashmir (Berg 1949b; Mirza 1972; 1974).
52. *Ctenopharyngodon idella* (Valenciennes, 1844). Introduced to Pahlavi Mordab, Iran, survived at least until 1967 but not reproducing (Armantrout 1969).
53. *Cyprinion macrostomus* Heckel, 1843. Tigris, Diyala and Karun River basins (Berg 1949b). Karaman (1971) divides this species into two subspecies *C. m. macrostomus* Heckel, 1843 from the upper Tigris River system and *C. m. tenuiradius* Heckel, 1846 from the Karun River, Shiraz (Kor and Mand Rivers) and lower Tigris-Euphrates River systems. Synonyms are *Cyprinion cypris* Heckel, 1843, *C. kais* Heckel, 1843, *C. neglectus* Heckel, 1846 and *C. tenuiradius* Heckel, 1846. Berg (1949b) retains *C. tenuiradius* as a distinct species.
54. *Cyprinion watsoni* (Day, 1872). Karaman (1971) includes the following synonyms from Iranian waters—*Scaphiodon irregularis* Day, 1872, *Barbus milesi* Day, 1880, *Scaphiodon microphthalmum* Day, 1880, *Cirrhina afghana* Gunther, 1889, *Barbus bampurensis* Nikolsky, 1899, *Cyprinion kirmanensis* Nikolsky, 1899, *Scaphiodon macmahoni* Regan, 1906, *S. baluchiorum* Jenkins, 1910, *S. daukesi* Zugmayer, 1912, *S. watsoni* var. *belensis* Zugmayer, 1912, and *Barbus baschakirdi* Holly, 1929. Based on these species distribution includes Seistan, Iranian Baluchistan, Kerman, the Baschakird mountains in southern Iran, the Mashkel and Nihing River drainages, and the(?) Tedzhen and (?) Hari River drainages. Berg (1949b) retains *Cyprinion irregularis* (Day, 1872), *C. microphthalmum* (Day, 1880) and *C. milesi* (Day, 1880) as distinct species.
55. *Cyprinus carpio* Linnaeus, 1758. South Caspian Sea rivers (Berg 1949a).
56. *Garra rossica* (Nikolsky, 1900). Iranian Baluchistan, Seistan, Kerman, and Tedzhen River (Berg 1949b; Karaman 1971). *Discognathus phryne* Annandale, 1919 is a synonym (Menon 1964) as is *Discognathichthys rossicus* (Nikolsky, 1900).
57. *Garra rufa* (Heckel, 1843). Menon (1964) records *G. r. obtusa* (Heckel, 1843) from the Karun and Karkheh River drainages, Kurdistan, Tigris and Diyala Rivers, Mand River in Fars, and the Bampur River in Baluchistan. Syno-

nyms include *Discognathus obtusus* Heckel, 1843, *D. crenulatus* Heckel, 1843 and *Garra persica* Berg, 1913.

58. *Garra variabilis* (Heckel, 1843). Tigris-Euphrates River systems and Karasu River (?Iran) (Khalaf 1961; Menon 1964; Karaman 1971). *Discognathichthys variabilis* (Heckel, 1843) is a synonym.
59. *Gobio gobio* (Linnaeus, 1758). *G. g. lepidolaemus* Kessler, 1872 is reported from the Tedzhen River and the synonym *Bungia nigrescens* Keyserling, 1861 from the Hari River (Berg 1949a; Keyserling 1861).
60. *Gobio persa* Gunther, 1899. Lake Reza'iyeh and Araxes River basins (Berg 1949a).
61. *Hemigarra elegans* (Gunther, 1868). Karaman (1971) divides this species into two subspecies, *H. e. elegans* (Gunther, 1868) from Mesopotamia and ? Euphrates River drainages and *H. e. adiscus* Annandale, 1919 from Seistan. *Discognathus adiscus* is regarded as a synonym. This species was originally described as *Tylognathus elegans* and is found in Tigris, Euphrates and Diyala Rivers (Mahdi, no date).
62. *Hemigrammocapoeta nanus* (Heckel, 1843). As *H. n. nanus* (Heckel, 1843) from Iran (Karaman 1971).
63. *Iranocypris typhlops* Bruun and Kaiser, 1950. Restricted to a natural well connected with a subterranean water supply at Kaaje-Ru, near the oasis of Baq-e-Loveh in the Zagros Mountains (Bruun and Kaiser 1950; Greenwood 1976).
64. *Labeo dero* (Hamilton-Buchanan, 1822). Mashkel River drainage in Pakistani Baluchistan (Mirza 1972). Not reported from Iran. *Labeo diplostomus* (Heckel, 1838) is a synonym (Mirza 1972). Berg (1949b) regards it as a distinct species, *Tylognathus diplostomus*.
65. *Labeo geodrosicus* Zugmayer, 1912. Mashkel River drainage in Pakistani Baluchistan (Zugmayer 1912; Mirza 1972). Not reported from Iran. Placed in the genus *Tylognathus* by Berg (1949b).
66. *Labeo macmahoni* Zugmayer, 1912. Dasht River in Pakistani Baluchistan, close to the Iranian border (Zugmayer 1912; Mirza 1972). Not reported from Iran.
67. *Leuciscus berak* (Heckel, 1843). Iraq (Mahdi and Georg 1969). Not reported from Iran.
68. *Leuciscus cephalus* (Linnaeus, 1758). *L. c. orientalis* Nordmann, 1840 is found in south Caspian Sea rivers, the Lake Reza'iyeh basin, and Karadj River (Berg 1949a). Khalaf (1961) and Berg (1949b) report it from Tigris River tributaries.
69. *Leuciscus gaderanus* Gunther, 1899. Lake Reza'iyeh basin (Gunther 1899).
70. *Leuciscus latus* (Keyserling, 1861). Tedzhen and Hari Rivers (Berg 1949a; Keyserling 1861).
71. *Leuciscus lepidus* (Heckel, 1843). Tigris River, Karkheh River drainage and Sefid River (Berg 1949b; Armantrout 1969).
72. *Leuciscus spurius* (Heckel, 1843). Iraq (Mahdi and Georg 1969). Not reported from Iran.
73. *Leuciscus ulanus* Gunther, 1899. Lake Reza'iyeh basin (Gunther 1899).
74. *Leuciscus zeregi* (Heckel, 1843). Iraq (Mahdi and Georg 1969; Mahdi, no date). Not reported from Iran.
75. *Mesopotamichthys sharpeyi* (Gunther, 1874). Karaman (1971) cites two subspecies *M. s. sharpeyi* (Gunther, 1874) from the upper Tigris River system and *M. s. faoensis* (Gunther, 1895) from the

lower Tigris River and probably Euphrates River. Not reported from Iran.

76. *Pelecus cultratus* (Linnaeus, 1758). Rare in the Sefid River (Berg 1949a).

77. *Rhodeus sericeus* (Pallas, 1776). As *R. s. amarus* (Bloch, 1782) reported from south Caspian Sea rivers by Berg (1949a).

78. *Rutilus frisii* (Nordmann, 1840). As *R. f. kutum* Kamenskii, 1901 in south Caspian Sea rivers (Berg 1949a).

79. *Rutilus rutilus* (Linnaeus, 1758). As *R. r. caspicus* Yakovlev, 1870 with natio *kurensis* Berg, 1932 in the southwestern Caspian Sea entering rivers and natio *knipowitschi* Pravdin, 1927 in the southeastern Caspian Sea entering rivers. *R. r. schelkovnikovi* Derjavin, 1926 is reported from Araxes River tributaries in Armenia (Zangu and Qarasu Rivers) close to Iran (Berg 1949a).

80. *Scardinius erythrophthalmus* (Linnaeus, 1758). South Caspian Sea coast (Berg 1949a).

81. *Schizocypris brucei* Regan, 1914. Seistan (Annandale and Hora 1920; Berg 1949b).

82. *Schizopygopsis stoliczkai* Steindachner, 1866. Helmand River delta in Seistan (Regan 1906; Vijayalakshmanan 1950).

83. *Schizothorax anjac* (Fowler and Steinitz, 1956). Seistan (Fowler and Steinitz 1956).

84. *Schizothorax pelzami* Kessler, 1870. Tedzhen River within Iran and the Shah River south of Astrabad (Berg 1949a). *Schizothorax raulinsii* Gunther, 1889 from the Hari River is a synonym (Berg 1949b). *S. p. iranicus* Karaman, 1969 is a subspecies from a spring in Tehran (Karaman 1969) (? locality).

85. *Schizothorax schumacheri* Fowler and Steinitz, 1956, Seistan (Fowler and Steinitz 1956).

86. *Schizothorax zarudnyi* (Nikolsky, 1897). Seistan (Nikolsky 1897; 1899). Synonyms are *Aspiostoma zarudnyi* Nikolsky, 1897 and *Barbus microlepis* Keyserling, 1861 (Berg 1949b).

87. *Tinca tinca* (Linnaeus, 1758). South Caspian Sea rivers (Berg 1949a).

88. *Tor canis* (Valenciennes, 1842). Reported from Iraq (Mahdi and Georg 1969). Not recorded from Iran. Karaman (1971) places *Barbus chantrei* (Sauvage, 1882) in synonymy with *Tor canis* but Berg (1949b) regards it as a distinct species.

89. *Tor grypus* (Heckel, 1843). Tigris-Euphrates system, Karun River (Karaman 1971) and Karkheh River (Svetovidov 1949). *Labeobarbus kotschyi* Heckel, 1843 is a synonym (Misra 1947; Karaman 1971). Berg (1949b) places this and the previous species in *Barbus*.

90. *Vimba vimba* (Linnaeus, 1758). As *V. v. persa* (Pallas, 1811) from the south Caspian Sea entering rivers (Berg 1949a).

FAMILY 8. COBITIDAE

1. *Cobitis linea* (Heckel, 1846). Pulvar River near Persepolis, Fars. Based on a single much-damaged specimen of doubtful validity.

2. *Cobitis taenia* Linnaeus, 1758. Reported from Caspian Sea drainages (Berg 1949a; Svetovidov 1949) and Iraq (Mahdi and Georg 1969). Recorded from the Kura River near the Iranian border as *C. t. satunini* Abdurahmanov, 1962 (Banarescu and Nalbant 1966).

3. *Noemachilus akhtari* Vijayalakshmanan, 1960. Helmand River in Afghanistan at Farakollum about 10 miles south of Gardan Diwar. Not recorded from Iran. Possibly *N. griffithi griffithi* according to Banarescu and Nalbant (1966).

4. *Noemachilus angorae* Steindachner, 1897. Araxes River and possibly Lake Reza-'iyeh (Berg 1949a) and Iraq (Khalaf 1961). Subspecies *N. a. bureschi* Drensky, 1928 from Iraq (Mahdi and Georg 1969) and upper Araxes River (Banarescu and Nalbant 1964) and *N. a. bergianus* Derjavin, 1934 from the Sefid River (Banarescu and Nalbant 1966). The latter subspecies is retained as a distinct species in Berg (1949a). *N. a. lenkoranica* Abdurahmanov, 1962 is found in Caspian Sea tributaries of the area south of the Kura River, close to the Iranian border.
5. *Noemachilus argyrogramma* (Heckel, 1846). Reported from Iraq (Mahdi and Georg 1969) without details of distribution. Not reported from Iran.
6. *Noemachilus baluchiorum* Zugmayer, 1912. Mashkel River drainage, Helmand drainage in southern Afghanistan, and Dasht River drainage of Pakistani Baluchistan, close to the Iranian border (Zugmayer 1912; Banarescu and Nalbant 1966; Mirza 1972, 1974). Banarescu and Nalbant (1966) regard it as a valid species but Berg (1949b) places it in synonymy with *Noemachilus montanus* (McClelland, 1839).
7. *Noemachilus bampurensis* Nikolsky, 1899. Bampur River in Iranian Baluchistan (Nikolsky 1899). Placed by Berg (1949b) in *N. montanus* but regarded as a distinct species by Banarescu and Nalbant (1966).
8. *Noemachilus brandti* Kessler, 1877. Upper and middle Araxes River (Berg 1949a), Karadj River and Lake Reza-'iyeh basin (Vladykov 1964).
9. *Noemachilus boutanensis* (McClelland, 1842). Helmand River in Afghanistan. Not recorded from Iran (Banarescu and Nalbant 1966).
10. *Noemachilus cristatus* Berg, 1898. Rivers and springs west of the Tedzhen River in Turkmenia (Berg 1949a), Atrek River and Hari River (Banarescu and Nalbant 1966).
11. *Noemachilus farwelli* Hora, 1934. Helmand River in Afghanistan, not recorded from Iran (Banarescu and Nalbant 1966).
12. *Noemachilus frenatus* (Heckel, 1843). River Tigris (Khalaf 1961) as *N. f. afrenatus* Battalgil, 1942 in Mahdi and Georg (1969).
13. *Noemachilus ghazniensis* Banarescu and Nalbant, 1966. Ghazni River tributary, Helmand River drainage of eastern Afghanistan. Not reported from Iran (Banarescu and Nalbant 1966).
14. *Noemachilus griffithi* Gunther, 1868. Helmand River drainage as *N. g. griffithi* Gunther, 1868. Not reported from Iran (Banarescu and Nalbant 1966).
15. *Noemachilus insignis* (Heckel, 1843). As *N. i. euphraticus* Banarescu and Nalbant, 1964 reported from Iraq and Anatolia in the Tigris and Euphrates River basins (Mahdi and Georg 1969; Banarescu and Nalbant 1964). Not recorded from Iran.
16. *Noemachilus kermanshahensis* Banarescu and Nalbant, 1966. From Kermanshah in the drainage of the Karun River (Banarescu and Nalbant 1966).
17. *Noemachilus kessleri* Gunther, 1889. Eastern Iran (Berg, 1949b). the Helmand River drainage in Afghanistan and the Mashkel River drainage in Pakistan (Banarescu and Nalbant 1966; Mirza 1975).
18. *Noemachilus longicauda* (Kessler, 1872). Tedzhen River drainage (Berg 1949a).
19. *Noemachilus malapterurus* (Cuvier and Valenciennes, 1846). Banarescu and Nalbant (1964) cite three subspecies, *N. m.*

malapterurus (Cuvier and Valenciennes, 1846) from the Tigris-Euphrates basin, *N. m. macmahoni* Chaudhuri, 1909 from the Helmand River delta in Seistan and Caspian Sea drainages such as the Sefid and Atrek Rivers, as well as the Lake Reza'iyeh basin, and *N. m. longicauda* (Kessler, 1872) from the Amu-Darya basin. Specimens from the Tedzhen River are placed in *N. m. longicauda* by Berg (1949a), in *N. m. malapterurus* by Nikolsky (1947) or in *N. m. macmahoni* by Banarescu and Nalbant (1964). Banarescu and Nalbant (1966) revise their earlier synonymy of *Noemachilus* (or *Adiposia*) *macmahoni* Chaudhuri, 1909 with *N. malapterurus* and place *N. macmahoni* in *N. rhadineus* Regan, 1906 and *N. m. longicauda* is listed as a distinct species.

20. *Noemachilus merga* (Krynicki, 1840). Terek, Sunzha, Sulak, Shura-ozen' and Samur River basins (Berg 1949a) north of Iran on the Caspian Sea west coast. Armantrout (1969) lists it from Iran.
21. *Noemachilus panthera* Heckel, 1843. Recorded from the Euphrates River in Iraq but not reported from Iran (Banarescu and Nalbant 1964; Mahdi and Georg 1969).
22. *Noemachilus persa* (Heckel, 1846). Lake Reza'iych drainage, Kor River drainage and Araxes River drainage (Banarescu and Nalbant 1966).
23. *Noemachilus prashari* Hora, 1933. Reported from the Mashkel River drainage as *N. p. lindbergi* Banarescu and Mirza, 1965 (Mirza 1972, 1975) and from a tributary of the Farah River in Afghanistan which drains into Iranian Seistan (Banarescu and Mirza 1965).
24. *Noemachilus rhadineus* Regan, 1906. Atrek and Sefid Rivers, Abkhar River in central Iran, Helmand River delta, Tedzhen River, probably most of Iran (Banarescu and Nalbant 1966).
25. *Noemachilus sargadensis* Nikolsky, 1899. Banarescu and Nalbant (1966) divide this species into three subspecies, *N. s. sargadensis* Nikolsky, 1899 from the Sargad River, Kerman, *N. s. paludani* Banarescu and Nalbant, 1966 from the Kabul River drainage in Arghanistan (not recorded from Iran), and *N. s. turcmenicus* Berg, 1932 from Turkmenistan near the Iranian border.
26. *Noemachilus smithi* Greenwood, 1976. Restricted to a natural well connected with a subterranean water supply at Kaaje-Ru, near the oasis of Baq-e-Loveh in the Zagros Mountains (Greenwood 1976).
27. *Noemachilus stoliczkai* (Steindachner, 1866). Reported from the Seistan endorheic drainage basin as *N. s. tenuis* Day, 1876 (Annandale and Hora 1920). Banarescu and Nalbant (1966) regard *N. tenuis* as a distinct species. *N. stenurus* Herzenstein, 1888 is a synonym (Berg 1949a).
28. *Noemachilus tenuis* Day, 1876. Helmand River drainage in Seistan (Banarescu and Nalbant 1966).
29. *Noemachilus tigris* (Heckel, 1843). *N. t. tigris* (Heckel, 1843) is reported from the Tigris River basin including the Karun River in Iran (Berg 1949b) but Banarescu and Nalbant (1966) consider Berg's figure to be untypical.
30. *Sabanejewia aurata* (Filippi, 1865). As *S. a. aurata* (Filippi, 1865) recorded from the Sefid and Tedzhen Rivers, the lower Euphrates River and presumably everywhere in western Iran (Banarescu and Nalbant 1966). *Cobitis hohenackeri* Kes-

sler, 1877 is a synonym (Berg 1949a).

31. *Sabanejewia caspia* (Eichwald, 1838). South Caspian Sea drainage basin in brackish and fresh water (Berg 1949a; Banarescu and Nalbant 1966).

ORDER 7. Siluriformes

FAMILY 9. Bagridae

1. *Mystus pelusius* (Solander, 1771). Reported from the Diyala River which has headwaters in Iran (Khalaf 1961). *Mystus haleppensis* (Cuvier and Valenciennes, 1839) and *M. colvilli* (Gunther, 1874) are synonyms according to Khalaf (1961) but Ladiges (1964) lists them as distinct species. Mahdi (no date) lists *Mystus aleppensis* (sic) as a synonym of *M. pelusius* but *M. colvilli* is retained as a distinct species.

FAMILY 10. Siluridae

1. *Silurus glanis* Linnaeus, 1758. Basin of Lake Reza'iyeh and Caspian Sea rivers (Berg 1949a).

FAMILY 11. Sisoridae

1. *Glyptothorax cous* (Linnaeus, 1766). Lesser Zab River which has its headwaters in Iran (Khalaf 1961). No definite record for Iran.
2. *Glyptothorax kurdistanicus* (Berg, 1931). Iran-Iraq border in the upper Tigris River basin at 36°N (Berg 1949b).
3. *Glyptothorax armeniacus* (Berg, 1918). Upper reaches of the Araxes or Euphrates River in Turkey, 42 km S.W. of Erzerum (the headwaters of these rivers are very close in this area and it is not certain which drainage the specimens came from) (Berg 1949a.). Not recorded from Iran.

FAMILY 12. Heteropneustidae

1. *Heteropneustes fossilis* (Bloch, 1801). Reported from the Shatt-el-Arab (Khalaf 1961)and Tigris and Euphrates Rivers (Mahdi, no date).

FAMILY 13. Ariidae

1. *Arius thalassinus* (Ruppell, 1835). Ascends Shatt-el-Arab (Khalaf 1961; Mahdi, no date).

ORDER 8. Gadiformes

FAMILY 14. Gadidae

1. *Lota lota* Linnaeus, 1758. Recorded from the Sefid River in the Caspian Sea basin (Berg 1949a) but Armantrout (1969) states that reports are uncertain.

ORDER 9. Atheriniformes

FAMILY 15. Cyprinodontidae

1. *Aphanius dispar* (Ruppell, 1828). Southern Iran, Kerman, Baluchistan, Bampur River, Mashkel River drainage, and coastal waters of the Persian Gulf (Berg 1949b; Mirza 1975). This distribution applies to *A. d. stoliczkanus* (Day, 1872) while *A. d. richardsoni* (Boulenger, 1907) is found in the Shatt-el-Arab (Berg 1949b; Al-Daham *et al.* 1977).
2. *Aphanius ginaonis* (Holly, 1929). Restricted to a hot spring at Ginao near Bandar Abbas in southern Iran (Holly 1929a; Coad 1979).
3. *Aphanius mento* (Heckel, 1843). Shatt-el-Arab (Al-Daham *et al.* 1977). *Aphanius cypris* (Heckel, 1846) is a synonym (Berg 1949b).
4. *Aphanius sophiae* (Heckel, 1846). Fars and Isfahan provinces, Shatt-el-Arab (Al-Daham *et al.* 1977; personal collections). *Cyprinodon blanfordii* Jenkins, 1910,

C. persicus Jenkins, 1910, *C. pluristriatus* Jenkins, 1910, *Lebias crystallodon* Heckel, 1846, and *L. punctatus* Heckel, 1846 are synonyms (Berg 1949b).

FAMILY 16. POECILIIDAE

1. *Gambusia affinis* (Baird and Girard, 1853). Introduced widely throughout Iran for mosquito control (Tabibzadeh *et al.* no date). *G. a. holbrooki* (Girard, 1859) is found throughout Iran but *G. a. affinis* (Baird and Girard, 1853) is reported from the Caspian basin only (Armantrout 1969; Kozhin 1957).

FAMILY 17. ATHERINIDAE

1. *Atherina mochon pontica* natio *caspia* Eichwald, 1831. Caspian Sea shores, in freshwater at Lenkoran near the Iranian border (Berg 1949a).

ORDER 10. Syngnathiformes

FAMILY 18. SYNGNATHIDAE

1. *Syngnathus nigrolineatus caspius* Eichwald, 1831. Caspian Sea, enters streams and rivers of Iran (Berg 1949a).

ORDER 11. Gasterosteiformes

FAMILY 19. GASTEROSTEIDAE

1. *Pungitius platygaster* (Kessler, 1859). Caspian Sea and mouths of rivers flowing into it (Berg 1949a).

ORDER 12. Perciformes

FAMILY 20. PERCIDAE

1. *Perca fluviatilis* Linnaeus, 1758. Sefid River in the Caspian Sea basin (Berg 1949a).
2. *Stizostedion lucioperca* (Linnaeus, 1758). Caspian Sea basin including Sefid and Atrek Rivers (Berg 1949a).
3. *Stizostedion marinum* (Cuvier and Valenciennes, 1828). Caspian Sea proper, never entering rivers (Berg 1949a).

FAMILY 21. CICHLIDAE

An undescribed species is found in rivers of southern Iran draining into the Persian Gulf (personal collections).

FAMILY 22. MUGILIDAE

1. *Liza auratus* (Risso, 1810). Caspian Sea, introduced from the Black Sea (Berg 1949a).
2. *Liza saliens* (Risso, 1810). Caspian Sea, introduced from the Black Sea (Berg 1949a).
3. *Mugil abu* (Heckel, 1843). Tigris River and tributaries (Khalaf 1961) presumably including Iranian waters. *M. a. zarudnyi* Berg, 1949 is reported from the upper Karun River and the Kerche (?Karkheh) River estuary (Berg 1949b; Svetovidov 1949). Also found in Lake Famur, Fars (personal collections).
4. *Mugil cephalus* (Linnaeus, 1758). Caspian Sea, introduced from the Black Sea (Berg 1949a).
5. *Mugil dussumieri* Cuvier and Valenciennes, 1836. Recorded from freshwaters of Iraq, not reported from Iran (Khalaf 1961).
6. *Mugil hishni* Misra, 1943. Rivers of Iraq not reported from Iran (Misra 1947).
7. *Mugil oligolepis* Bleeker, 1859. Shatt-el-Arab (Khalaf 1961).

FAMILY 23. GOBIIDAE

1. *Anatirostrum profundorum* (Berg, 1927). Reported from 37° 58′N, 52° 22′E, close to Iranian waters (Berg 1949a).
2. *Asra turcomana* Iljin, 1941. South Caspian Sea (Berg 1949a).
3. *Benthophilus baeri* Kessler, 1877. South Caspian Sea (Berg 1949a).

4. *Benthophilus ctenolepidus* Kessler, 1877. South and central Caspian Sea (Berg 1949a).
5. *Benthophilus granulosus* Kessler, 1877. Throughout Caspian Sea (Berg 1949a).
6. *Benthophilus grimmi* Kessler, 1877. Two subspecies *B. g. grimmi* Kessler, 1877 and *B. g. kessleri* Berg, 1927 both from central and south Caspian Sea (Berg 1949a).
7. *Benthophilus leptocephalus* Kessler, 1877. South Caspian Sea (Berg 1949a).
8. *Benthophilus macrocephalus* (Pallas, 1787). Caspian Sea including southern coast, approaches river mouths (Berg 1949a).
9. *Benthophilus stellatus* (Sauvage, 1874). A distinct subspecies *B. s. leobergius* Iljin, 1949 throughout freshened parts of Caspian Sea to the southern coast (Berg 1949a).
10. *Boleophthalmus dussumieri* Cuvier and Valenciennes, 1837. Shatt-el-Arab (Khalaf 1961) and Karun River (Berg 1949b).
11. *Hyrcanogobius bergi* Iljin, 1939. North Caspian Sea (Berg 1949a) but Armantrout (1969) records it from Iran.
12. *Knipowitschia longicaudata* (Kessler, 1877). Brackish parts of Caspian Sea (Berg 1949a), perhaps Iran (Armantrout 1969).
13. *Mesogobius gymnotrachelus* (Kessler, 1857). As the subspecies *M. g. macrophthalmus* (Kessler, 1877) found everywhere in the Caspian Sea (Berg 1949a).
14. *Mesogobius nonultimus* (Iljin, 1936). South-east and north Caspian Sea (Berg 1949a).
15. *Neogobius bathybius* (Kessler, 1877). Caspian Sea opposite Svinoi Island, south of Baku (Berg 1949a). Not reported from Iran.
16. *Neogobius caspius* (Eichwald, 1831). All of the Caspian Sea (Berg 1949a).
17. *Neogobius cephalarges* (Pallas, 1811). Found in south Caspian Sea rivers (Berg 1949a) as *N. c. constructor* (Nordmann, 1840). *Neogobius platyrostris cyrius* Kessler, 1874) is a synonym (Berg 1949a).
18. *Neogobius fluviatilis* (Pallas, 1811). As the subspecies *N. f. pallasi* (Berg, 1916) found in the Caspian Sea (Berg 1949a) including Iranian waters (Armantrout 1969).
19. *Neogobius kessleri* (Gunther, 1861). All coasts of the Caspian Sea (Berg 1949a).
20. *Neogobius melanostomus* (Pallas, 1811). As *N. m. affinis* (Eichwald, 1831) from the Caspian Sea including south coast rivers (Berg 1949a).
21. *Periophthalmus koelreuteri* (Pallas, 1770). Enters rivers of southern Iran (Holly 1929b; Werner 1929).
22. *Pomatoschistus caucasicus* Berg, 1916. Caspian Sea coasts entering freshwaters (Berg 1949a).
23. *Proteorhinus marmoratus* (Pallas, 1811). Caspian Sea including rivers of the south (Berg 1949a)
24. *Proteorhinus semipellucidus* (Kessler, 1877). Mouth of the Karasu River, Astrabad Bay, Iran. May be a synonym of *P. marmoratus* (Berg 1949a).

FAMILY 24. CHANNIDAE

1. *Ophiocephalus gachua* Hamilton-Buchanan, 1822. Baluchistan (Bampur River), Kerman (Haliri River) (Coad, MS) and Mashkel River drainage (Zugmayer 1912).

FAMILY 25. MASTACEMBELIDAE

1. *Mastacembelus mastacembelus* (Solander, 1794). Tigris-Euphrates drainage, Dalaki

and Mand Rivers and Lake Famur in Iran (Berg 1949b; personal collections). *M. haleppensis* (Bloch and Schneider, 1801) and *M. simack* (Walbaum, 1792) are synonyms (Berg 1949b; Sufi 1957).

ORDER 13. Pleuronectiformes

FAMILY 26. PLEURONECTIDAE

1. *Pleuronectes flesus luscus* Pallas, 1811. Introduced to the Caspian Sea and found in the southern part near Iranian shores (Berg 1949a).

DISCUSSION

Table 1 summarises the numbers of genera and species in each family and gives some indication of the distribution of families. Only genera and species definitely recorded from

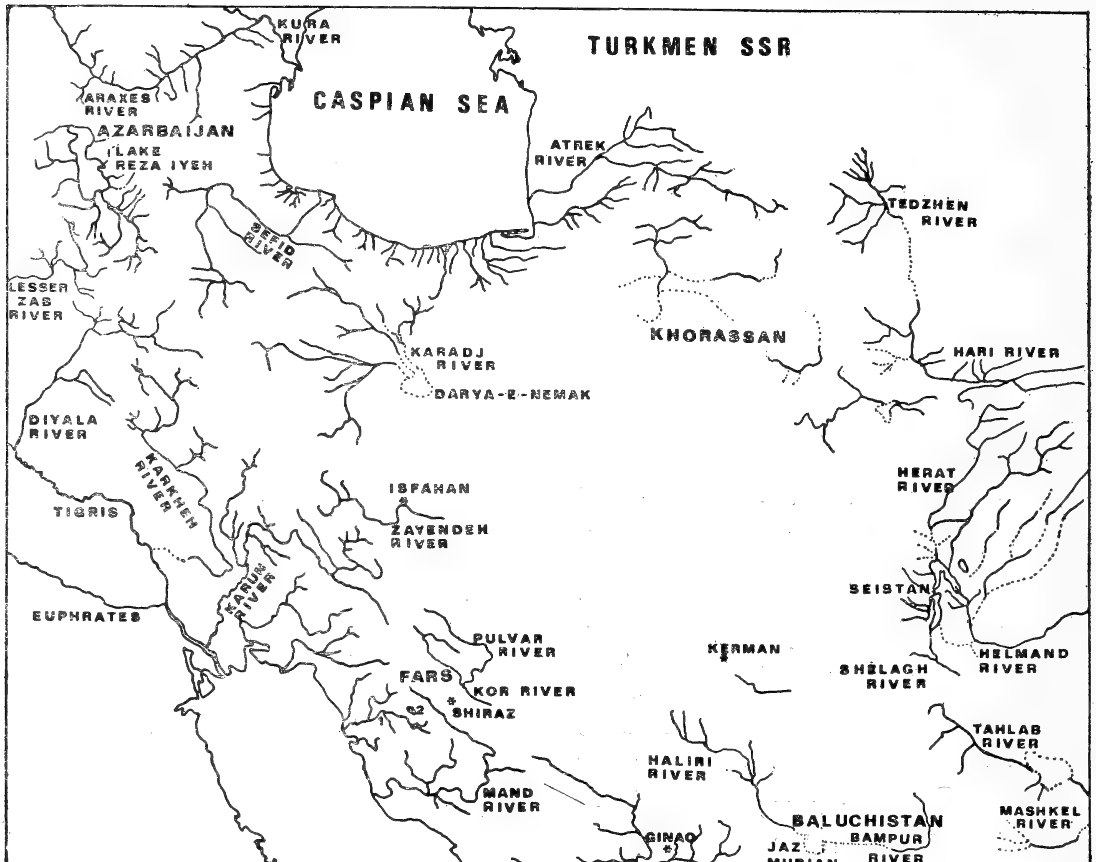


Fig. 1. Principal rivers and lakes of Iran including border drainages (dotted lines indicate seasonal lakes and rivers with intermittent flow).

Iran are included here. There are a large number of endorheic drainages in Iran but these have not all been well studied ichthyologically and only a selection can be given. There are several minor endorheic drainages in Fars, for example, and here two are combined (Shiraz and Kor River) and a third is treated separately (Lake Famur) for convenience. The major drainages referred to are shown in Figure 1.

There are 26 families of fishes reported from Iran of which 17 are represented by a single species and of the remainder only Cyprinidae, Cobitidae and Gobiidae have more than 10 species. The ichthyofauna is dominated by the Cyprinidae and Cobitidae, the only two native families to be found in all drainages. Most Gobiidae are restricted to the Caspian Sea proper with some species penetrating into rivers. The Cyprinodontidae, comprising 4 species, is a widely distributed family in southern Iran.

Eleven families have a marine origin and 3 consist wholly or in part of introduced species. The Poeciliidae is a freshwater Central and southern North American family introduced to Iranian waters for control of mosquito larvae. Cracraft (1974) has given a postulated geographical origin for freshwater fish families. In Iran 6 families are from Laurasia and 8 from Gondwanaland but in terms of number of genera (and species) the Iranian freshwater fish fauna is dominated by the Laurasian faunal element (43 Laurasian genera as opposed to 8 from Gondwanaland).

The Caspian Sea basin and Persian Gulf drainages have the richest fish fauna in terms of numbers of families but both these drainages are by far the largest under consideration here. In addition the Caspian Sea contains both freshwater and marine elements in its fauna and such northern families as Esocidae, Salmonidae, Gasterosteidae and Percidae which are not found in southern Iran. Salmonidae are also reported from endorheic drainages immediately south of the Caspian basin. Marine families entered the now isolated Caspian basin during the Tertiary when it was connected to the Atlantic Ocean via the Black Sea (Zenkevitch 1963). Persian Gulf drainages of Iran show clear affinities in their fish fauna with the Tigris-Euphrates system of Iraq. Kassler (1973) has pointed out that the sea level fell by as much as 120 m. during the Pleistocene and this would have emptied the shallow Persian Gulf as far south as the Straits of Hormuz. Rivers which are now isolated from the Tigris-Euphrates system would have then become tributaries of a combined Tigris-Euphrates river emptying directly into the Sea of Oman. Inland from the present Gulf the diversity, even at the family level, decreases with altitude and with distance from the Tigris-Euphrates system. Inland endorheic drainages at high altitudes, such as the Zayendeh River and the Shiraz and Kor River drainages, have fewer families represented in their fish fauna than, for example, the endorheic but low altitude Lake Famur and rivers draining into the Persian Gulf.

In the south-east of Iran, for example the Jaz Murian basin, Oriental fishes are found represented at the family level by the Channidae but probably also reflected in species of Cyprinidae and Cobitidae which have been reported from border drainages in Pakistan but not yet recorded from Iran.

The eastern border regions of Iran with Afghanistan, for example the Seistan endorheic drainage basin, contain species of wider distribution within Iran but also elements of a High Asian fish fauna, such as the cyprinid tribe Schizothoracini, which entered this lowlying area via the Helmand River from the

TABLE 1

NUMBERS OF GENERA AND SPECIES AND DISTRIBUTION OF IRANIAN FRESHWATER FISH FAMILIES

(G = Gondwanaland faunal element, I = introduced, L = Laurasian faunal element, M = marine).

Family	Origin	Number of genera	Number of species	Caspian Sea and tributaries	Persian Gulf drainages	Endorheic drainages: Seistan	Jaz Murian	Shiraz and Kor River	Lake Famur	Zayendeh River	Lake Reza'i-yeh	Karadj River and Darya-e-Nemak	Number of drainages
Petromyzonidae	M	1	1	+	–	–	–	–	–	–	–	–	1
Carcharhinidae	M	?1	?1	–	+	–	–	–	–	–	–	–	1
Acipenseridae	L	2	5	+	–	–	–	–	–	–	–	–	1
Clupeidae	M	3	8	+	+	–	–	–	–	–	–	–	2
Esocidae	L	1	1	+	–	–	–	–	–	–	–	–	1
Salmonidae	L, I	1	2	+	+	–	–	–	–	–	+	+	4
Cyprinidae	L	34	73	+	+	+	+	+	+	+	+	+	9
Cobitidae	L	3	20	+	+	+	+	+	?	+	+	+	8-9
Siluridae	G	1	1	+	(+)*	–	–	–	–	–	+	–	2
Bagridae	G	1	1	–	+	–	–	–	–	–	–	–	1
Sisoridae	G	1	1	–	+	–	–	–	–	–	–	–	1
Saccobranchidae	G	1	1	–	+	–	–	–	–	–	–	–	1
Ariidae	M	1	1	–	+	–	–	–	–	–	–	–	1
Gadidae	M	1	1	+	–	–	–	–	–	–	–	–	1
Cyprinodontidae	G	1	4	–	+	–	+	+	+	+	–	–	5
Poeciliidae	I	1	1	+	+	+	+	+	+	+	+	+	9
Atherinidae	M	1	1	+	–	–	–	–	–	–	–	–	1
Syngnathidae	M	1	1	+	–	–	–	–	–	–	–	–	1
Gasterosteidae	M	1	1	+	–	–	–	–	–	–	–	–	1
Percidae	L	2	3	+	–	–	–	–	–	–	–	–	1
Cichlidae	G	?1	?1	–	+	–	–	–	–	–	–	–	1
Mugilidae	M, I	2	5	+	+	–	–	–	+	–	–	–	3
Gobiidae	M	10	?22	+	+	–	–	–	–	–	–	–	2
Channidae	G	1	1	–	–	–	+	–	–	–	–	–	1
Mastacembelidae	G	1	1	–	+	–	–	–	+	–	–	–	2
Pleuronectidae	M, I	1	1	+	–	–	–	–	–	–	–	–	1
Total		75	159	17	15	3	5	4	5-6	4	5	4	

* A different species, *Silurus triostegus* (Heckel, 1843), from that of Caspian Sea and Lake Reza'iyeh drainages is found in the Tigris River but has not been reported from Iran.

mountains of Afghanistan.

In summary, the freshwater fish fauna of Iran belongs to the Palaearctic region and the principal families are the Cyprinidae and Cobitidae, and additionally the Gobiidae in the Caspian Sea basin. However, there is a relatively high diversity of families because of marine and Gondwanaland faunal elements although the fauna is dominately Laurasian. Much systematic work remains to be done to elucidate the zoogeography of Iranian freshwater fishes at the species level, to eliminate synonymies and to provide keys and detailed species descriptions as a basis for other studies.

Acknowledgements

I am indebted to Dr. B. Kholdebarin, Chairman of the Biology Department, Pahlavi University for his assistance in arranging field trips and to the drivers and assistants who helped collect material on which this work is partly based.

This research was financed by a Pahlavi University Research Council grant number 35-A5-149-172.

References

Al-Daham, N. K., Huq, M. F. & Sharma, K. P. (1977): Notes on the ecology of fishes of the genus *Aphanius* and *Gambusia affinis* in Southern Iraq. *Freshwater Biol. 7*: 245-251.

Annandale, N. & Hora, S. L. (1920): The fish of Seistan. *Rec. Indian Mus. 18*: 151-203+3 plates.

Armantrout, N. B. (1969): The Fishes of Iran. A Preliminary Checklist. MS, 39 p.

Banarescu, P. & Mirza, M. R. (1965): *Noemachilus lindbergi* n. sp., a new loach from Afghanistan and West Pakistan. *Senck. biol. 46*: 265-269.

Banarescu, P. & Nalbant, T. (1964): Süsswasserfische der Türkei. Cobitidae. *Mitt. Hamburg. Zool. Mus. Inst. 61*: 159-201.

——————— (1966): Cobitidae (Pisces) from Afghanistan and Iran. *Vidersk. Meddr. Dansk Naturh. Foren. 29*: 149-186 + 3 plates.

Berg, L. S. (1925): Description d'une nouvelle espece du genre *Alburnus* (Pisces), provenant du bassin du lac d'Ourmi. *Ann. Mus. Zool. Acad. Sci. URSS 1925*: 213-214.

——————— (1932): Eine neue *Barilius*-Art (Pisces, Cyprinidae) aus Mesopotamien. *Zool. Anz. 100*: 332-334.

——————— (1948-1949a): Freshwater fishes of the U.S.S.R. and adjacent countries. Israel Program for Scientific Translations, Jerusalem, 1962, 1963, 1965. 3 vols., vol. 1 1948, vols. 2 and 3 1949.

——————— (1949b): Freshwater fishes of Iran and adjacent countries. *Trudy Zool. Inst. Akad. Nauk SSSR 8*: 783-858.

Borodin, N. (1926): *Acipenser persicus*, a sturgeon from the Caspian Sea. *Ann. Mag. Nat. Hist.* ser. 9, *20*: 26-28.

Bruun, A. F. & Kaiser, E. W. (1950): *Iranocypris typhlops* n. g., n. sp., the first true cavefish from Asia. *Dan. scient. Invest. Iran 4*: 1-8.

Coad, B. W. (1979): A re-description of *Aphanius ginaonis* (Holly, 1929) from southern Iran (Osteichthyes: Cyprinodontiformes). *J. nat. Hist.* in press.

Cracraft, J. (1974): Continental drift and vertebrate distribution. *Ann. Rev. Ecol. Syst. 5*: 215-261.

Fowler, H. W. & Steinitz, H. (1956): Fishes from Cyprus, Iran, Iraq, Israel and Oman. *Bull. Res. Counc. Israel* 5B: 260-292.

Greenwood, P. H. (1976): A new and eyeless cobitid fish (Pisces, Cypriniformes) from the Zagros Mountains, Iran. *J. Zool., Lond.* 180: 129-137.

Gunther, A. (1899): Fishes (of Lake Urmia). *J. Zool. Linn. Soc. 27*: 381-391.

Heckel, J. J. (1843): Süsswasser-Fische Syriens. In: Russegger, J. Reisen in Europa, Asien und Afrika. Vol. 1, part 2: 1044-1099 + plates 2-13.

——————— (1846): Naturhistorischen Anhang. In: Russegger, J. Reisen in Europa, Asien und Afrika. Vol. 2, part 3: 209-254 + plates 14-19. Die Fische Persiens gesammelt von Theodor Kotschy. In: Russegger, J. Reisen in Europa, Asien und Afrika. Vol. 2, part 3: 255-272 + plate 22.

Holly, M. (1929a): Drei neue Fischformen aus

Persien. *Anz. Akad. Wiss., Wien 66*: 62-64.

———— (1929b): Beiträge zur Kenntnis der Fischformen Persiens. *Zool. Anz. 85*: 183-185.

HUNT, R. S. (1951): The sharks of Ahwaz. *J. Roy. Army Med. Corps 97*: 79-85.

KARAMAN, M. S. (1969): Süsswasserfische der Türkei. 7 Teil. Revision der kleinasiatischen und vorderasiatischen Arten des Genus *Capoeta* (*Varicorhinus*. partim). *Mitt. Hamburg. Zool. Mus. Inst. 66*: 17-54 + 6 plates.

———— (1971): Süsswasserfische der Türkei. 8 Teil. Revision der Barben Europas, Vorderasiens und Nordafrikas. *Mitt. Hamburg. Zool. Mus. Inst. 67*: 175-254 + 2 plates.

KASSLER, P. (1973): The structural and geomorphic evolution of the Persian Gulf. In: Purser, B. H. (Ed.) The Persian Gulf. Springer-Verlag, Berlin. p. 11-33.

KEYSERLING, E. (1861): Neue Cypriniden aus Persien. *Zeit. Ges. Naturwiss. 17*: 1-24+9 plates.

KHALAF, K. T. (1961): The marine and freshwater fishes of Iraq. Ar-Rabitta Press, Baghdad. 164 p.

KOSSWIG, C. (1955): Zoogeography of the Near East. *Syst. Zool. 4*: 49-73 + 96.

KOZHIN, N. I. (1957): Data on the ichthyofauna of the Iranian coast of the Caspian Sea. *Vopr. Iktiol. 8*: 8-18.

KURONUMA, K. & ABE, Y. (1972): Fishes of Kuwait. Kuwait Institute for Scientific Research. 123 p.

LADIGES, W. (1960): Süsswasserfische der Türkei. 1 Teil. Cyprinidae. *Mitt. Hamburg. Zool. Mus. Inst. 58*: 105-150.

———— (1964): Süsswasserfische der Türkei. 3. Teil, restliche Gruppen. *Mitt. Hamburg. Zool. Mus. Inst. 61*: 203-220.

MAHDI, N. (no date): Fishes of Iraq. Ministry of Education, Baghdad. 82 p.

MAHDI, N. & GEORG, P. V. (1969): A systematic list of the vertebrates of Iraq. *Iraq. Nat. Hist. Mus. Publ. 26*: 1-104.

MENON, A. G. K. (1964): Monograph of the genus *Garra* Hamilton. *Mem. Indian Mus. 14*: 173-260 + 6 plates.

MISRA, K. S. (1947): On a second collection of fish from Iraq. *Rec. Indian Mus. 45*: 115-128.

MIRZA, M. R. (1972): Freshwater fishes of Baluchistan Province, Pakistan, *Biologia, Lahore 18*: 153-190.

———— (1974): Freshwater fishes and ichthyogeography of Baluchistan and adjoining areas of the Indus Plain, Pakistan. *Biologia, Lahore 20*: 67-82.

———— (1975): Freshwater fishes and zoogeography of Pakistan. *Bijd. Tot Dier. 45*: 143-180.

NELSON, J. S. (1976): Fishes of the World. John Wiley & Sons, New York. 416 p.

NIKOLSKY, A. M. (1897): Reptiles, amphibians and fishes collected by N. A. Zarudny in eastern Persia. *Ann. Mus. Zool. Acad. Sci. St. Petersburg 2*: 306-348.

———— (1899): Reptiles, amphibians and fishes of the second journey of N. A. Zarudny in Persia in 1898. *Ann. Mus. Zool. Acad. Sci. St. Petersburg 4*: 375-417.

NIKOLSKY, G. V. (1947): The loaches of the inland waters of Turcmenia. *Bull. Soc. Nat. Moscou ser. biol. 52*: 29-34.

REGAN, C. T. (1906): Two new cyprinoid fishes from the Helmand Basin. J. Asiatic Soc. Bengal 2. (new series): 8-9.

SUFI, S. M. K. (1957): Revision of the Oriental fishes of the Family Mastacembelidae. *Bull. Raffles Mus., Singapore 27*: 93-146.

SVETOVIDOV, A. N. (1945a): On *Clupeonella delicatula* (Nordmann) of the Caspian and that of the Black and Azov Seas. *Compt. Rend. Acad. Sci. URSS 46*: 207-208.

———— (1945b): *Chalcalburnus chalcoides iranicus* subsp. nova from the Caspian coast of Iran, and some zoogeographical problems of the southern part of this sea. *Compt. Rend. Acad. Sci. URSS 48*: 142-144.

———— (1949): Fishes of Iran from materials collected by Acad. E. N. Pavlovskii. *Trudy Zool. Inst. Akad. Nauk SSSR 8*: 859-869.

———— (1952): Clupeidae. Fauna of U.S.S.R. Fishes. Vol. 2, no. 1. Israel Program for Scientific Translations, Jerusalem, 1963. 428 p.

TABIBZADEH, I., BEHBEHANI, G. & NAKHAI, R. (no date): Use of Gambusia fish in the malaria eradication programme of Iran. *World Health Organization*, WHO/MAL/70.716, 13 p.

TORTONESE, E. (1934): Pesci della Persia raccolti dal Marchese Giacomo Doria. *Boll. Mus. Zool. Anat. comp., Torino 44*: 1-18.

VIJAYALAKSHMANAN, M. A. (1950): A note on the fishes from the Helmund River in Afghanistan,

with the description of a new loach. *Rec. Indian Mus. 47*: 217-224.

VLADYKOV, V. D. (1964): Inland fisheries resources of Iran especially of the Caspian Sea with special reference to sturgeon. *FAO Report* no. 1818, 51 p.

WERNER, F. (1929): Beiträge zur Kenntnis der Fauna von Syrien und Iran. *Zool. Anz. 81*: 238-245.

ZENKEVITCH, L. (1963): Biology of the Seas of the U.S.S.R. George Allen and Unwin. 955 p.

ZUGMAYER, E. (1912): Eight new fishes from Baluchistan. *Ann. Mag. Nat. Hist.*, ser. 8, *10*: 595-599.

BIOECOLOGY AND ZOOGEOGRAPHY OF TERMITE GENUS *CRYPTOTERMES* (ISOPTERA: KALOTERMITIDAE) IN THE INDIAN REGION[1]

M. L. THAKUR[2]

(*With a text-figure*)

The species of termite genus *Cryptotermes* belong to one of the most economically important group of termites under the large and primitive family Kalotermitidae. Popularly known as "*powder post termites*" these termites are capable of tolerating very low moisture condition for a long time. The small size of the colony which can be lodged in small wooden articles, make them ideally suited for easy transportation and introduction to new habitats, thus posing a potential danger to man-made structures and causing quarantine problems. The paper discusses in detail bioecology and economic significance of species of this group of termites in the Indian Region, with possible measures to check the introduction and spread of these termites to new zoogeographical regions.

INTRODUCTION

The species of termite genus *Cryptotermes* belong to one of the most economically important group of drywood termites under the large and primitive family Kalotermitidae. They are generally tropicopolitan in distribution, occurring throughout the tropical and sub-tropical regions of the world, with exception of a few species, which have extended their range of distribution to the warmer temperate regions. They attack dead and dry portions of living trees in nature and woodwork in buildings, household furniture and other wooden structures. Their presence is easily detected in infested material by piles of tiny pellets, thrown out from the nest. This has given them the popular name "powder post termites". In many parts of the world, rising cost of repairs to the damage done by these termites, has focussed the attention of builders, pest control operators, etc. on this genus. In view of the fact, that the species are likely to be transported to different parts of the world through human agency and are likely to cause serious damage to wooden structures in the country of introduction, they present a serious quarantine problem.

Assmuth (1913) was probably the first to report the occurrence of the genus *Cryptotermes* in India (Bangalore) in "a dried up stump and a branch of a live *Ficus* tree". Following him, Snyder (1934), Roonwal & Pant (1953), Moszkowski (1955), Roonwal & Sen-Sarma (1956), Sen-Sarma & Mathur (1957), Mathur & Thapa (1962), Roonwal & Chhotani (1962), Chhotani (1963, 1970), Gay (1967, 1970), Chatterjee & Thakur (1968), Roonwal & Bose (1970) and Sen-Sarma & Thakur (1974) have added considerably to our knowledge of the termite genus *Cryptotermes*, its distribution and biology, etc. from the Indian Region. In an exhaustive

[1] Paper presented at the Symposium on Oriental Entomology—1973 (4-11 Nov., 1973), Calcutta, organised jointly by the University Grants Commission and the University of Calcutta. Accepted December 1977.

[2] Forest Entomology Branch, Forest Research Institute & Colleges, Dehra Dun.

and well illustrated monograph, Chhotani (1970) has dealt with taxonomy, zoogeography and phylogeny of this genus from the Oriental Region. He has reported the following four species from India, namely *Cryptotermes domesticus, C. dudleyi, C. havilandi* and *C. roonwali*. Gay (loc. cit.) and many other workers do not agree with the view of Moszkowski (1955) and Chhotani (1970), regarding the occurrence of the species *havilandi* in India (vide infra). In view of this fact and also as some additional information on the distribution and biology of this genus has been collected from the extensive surveys of wood-destroying termites in various parts of the country, it has been thought desirable to review the whole situation. Information available in ledger files has also been incorporated.

Bioecology and distribution of species

1. **Cryptotermes bengalensis** Snyder*

Bioecology:

Cryptotermes bengalensis is a native species, nesting primarily in dry and dead portions of living trees, colony hardly extending into the living parts of the host. Its new records of host plants are *Carapa moluccensis* var. *gangetica* in Jokhai forest (Assam), *Adina cordifolia* in Surhi Village, Lormi Range, Bilaspur (M.P.), *Ficus benghalensis* in Kesla Range, Hoshangabad (M.P.), *Mangifera indica* in Gorakhpur and Ramnagar (U.P.) and Jaisinghnagar (Sahdol District, M.P.). Earlier, it was recorded infesting living trees of *Heritiera minor* in Sunderbans (Snyder 1934) and *Ficus benghalensis* at Mandla Fort in Madhya Pradesh (Chhotani 1963).

This species has also been recorded attacking dry and sound wooden structures, like posts, doors and window sills and wooden rafters in buildings in Assam, West Bengal and Tripura. The infested material exhibits excavations extending along the direction of grain and not across the grain of the wood. There are series of flat chambers, which are wide in the middle and tapering at both ends. Each chamber is connected with the adjoining chamber by narrow passage ways. In soft timber of uniform texture like *Gmelina arborea,* irregular cavities connected with narrow passageways are formed, which may further be gnawed to form wider cave-like chambers with irregular walls. Mostly, the outer cavities are empty, with faecal pellets being piled up in some parts, to be ejected out later on the ground or other substratum. The outer surface of the attacked wood is always left intact, while the remaining outer wall is often gnawed away to such an extent that only a very thin outer shell is left with neat small cricular holes which connect the inner galleries and cavities with the open air as well as act as outlets for ejection of faecal pellets and perhaps also for swarming of alates. Some of these are no more in use. In case of infested rafters, beams, etc., the faecal matter often rain down and pile up on tables, beds and ground. The pellets are small, brown and hexagonal in shape. The colour of these pellets, however, generally corresponds with the natural shade of the attacked wood.

It is of interest to note that this species has recently been collected at Belonia Forest Rest House in Tripura, attacking both the

* Moszkowski (1955) synonymised this species with *C. havilandi* (Sjostedt). Chhotani (1963, 1970) also followed her and supported this synonymy. However, Ahmed (1965), Gay (1967, 1970), Mathur & Thapa (1962, 1965), Roonwal & Chhotani (1962), Sen-Sarma & Thakur (1974) and Sen-Sarma *et al.* (1975), have rejected this arrangement and consider *C. bengalensis* as a valid species. I fully agree with these authorities and have followed them in this publication.

wooden structures of the Rest House as well as the dead branches of living trees of *Artocarpus heterophyllus* and *Shorea robusta*. This clearly indicates that this species may invade the "modified environment of man" in localities in Madhya Pradesh and Uttar Pradesh, where it now occurs in the wild state, when natural resources are either exhausted or not easily available.

Specific data pertaining to the swarming in nature is not available. However, emergence from preinfested logs under laboratory conditions at the Forest Research Institute was recorded from the 1st week of May to 3rd week of June. Alates have also been collected in the field in the month of January. Thus it appears that swarming occurs mostly during the first half of the year.

Distribution:

This species was originally collected in 1934 in Sunderbans (21°40′—22°50′ N and 88°10′—89°40′ E). It has been since recorded from ASSAM: Digboi (Mathur & Thapa 1965), Jokhai Reserve Forest. MADHYA PRADESH: Mandla Fort and BANGLADESH: Dacca (Chhotani 1970). The following are the new records of its distribution: WEST BENGAL: Jhingakhali forest (Sunderbans). MADHYA PRADESH: Surhi village, Lormi Range (Bilaspur); Kesla Range (Hoshangabad) and Jaisinghnagar (Sahdol) TRIPURA: Agartala: Belonia and Paratia. UTTAR PRADESH: Gorakhpur and Ramnagar.

2. **Cryptotermes domesticus** (Haviland)

Bioecology:

This species was originally described from Singapore and Sarawak in 1898 and was reported to be a common house hold pest. The centre of origin of this species is not known. The only known reference of its occurrence in exclusively wild habitat, such as old stumps, dead trunk, dry portions of living trees is from Botal Tabago Island off the Coast of Formosa (Hozawa 1915 and Gay 1970). From this Gay (1970) has concluded that the centre of origin of this species is the coastal regions of associated Islands of South-East Asia. Household furniture are the main targets of this species.

In India, this is an introduced species, but it is not known as to how and when it was introduced. It has so far been recorded from Kerala only where it was found nesting in a boat, fence posts and a timber godown. Snyder (1934) also reported this species from India but did not mention the precise locality.

Emergence of alates and swarming periods vary with the locality and records in literature show that swarming in this species occurs during the greater part of the year from April to November. Adults have also been collected in June-July and November in Solomon Islands; in October in Colombo (Sri Lanka) and Thursday Islands (north Australia) and also at night during April in Hakgala (Sri Lanka).

Distribution:

This species is very widely distributed and has been recorded from Indo-Malayan, Papuan and Neotropical Regions. From the Indo-Malayan Region, it has been recorded as follows: SRI LANKA: Hakgala and Peradeniya. CHINA: Kachak, Hainan Islands, Kwangtung and Yunan Provinces. FORMOSA: Botal Tabago and Taihoku. INDIA: Travancore and Trivandrum. BORNEO: Sarawak, South-East Borneo, Karakatao Islands and Sinagang (Simlur). Java and Sumatra (Deli). JAPAN: Oshagakijima (Leo-Shoo Isl.) and Ogasawarjima (Bonin Isl.). Singapore. THAILAND: Bangkok. VIETNAM: Saigon and Tonkin.

3. **Cryptotermes dudleyi** Banks

Bioecology:

This is also an introduced species in India

and is restricted to coastal regions, where it is a serious pest damaging and destroying all types of wooden structure in buildings. A serious infestation by this species was discovered on 11.12.1953 by Choudhry (1955) in Khulna (Bangladesh). He found a big post of *Heritiera minor* (6.6 m long and 0.6 m diameter) seriously attacked by this species in a shed. In the same shed, many sawn pieces (10 cm × 10 cm × 12.5 cm) of the same wood were also found infested at a few places. Large quantities of pellets were noticed lying on the ground as well as on the beams. According to him, the introduction of this species in the Indian Region was a recent one and it came from the Indo-Malayan Region, possibly during the World War II or subsequently, when Khulna became an important port after the partition of India in 1947.

It attacks wooden poles, pillars, doors, windows and all types of bamboo structures, including split bamboos used as rafters. Its intensity of attack is usually of a severe nature and the wooden structures are completely excavated and riddled with galleries in a short time. Fine small holes, resembling the typical Bostrychid attack are visible on the outer surface which otherwise appears to be quite sound. The galleries run along the grain of the timber, widening out at places and without any trace of earth on the inside or outside portions. The faecal pellets are usually blackish in colour and oblong in shape. The coloration, however, varies according to the texture of the host. Sen-Sarma and Mathur (1957) recorded this species as a serious pest in buildings in Sunderbans. Almost all the wooden and bamboo constructions near the creeks and rivers in Sunderbans were found highly susceptible to attack by this species. Chatterjee and Thakur (1968) reported this species from Daman where it was found nesting in a wooden pole of a verandah in the P.W.D. Rest House.

Some information is available in literature regarding the swarming and emergence record of this species. Choudhry (1955) collected the imagos after splitting open sawn pieces in Khulna on 11-xii-1953; 7th January 1954 in Sunderbans (Sen-Sarma & Mathur 1957); 24th March 1911 in Ross Is. (South Andamans); 16th May 1930 in Peradeniya (Sri Lanka) from woodwork of a building; 3rd March 1931, in Kedugannawa (Sri Lanka) and 14th May 1935, in Canal Zone (Panama) (Sen-Sarma & Thakur 1974). From this it appears that this species usually swarms from November to May.

Distribution:

Commonly known as American powder post termite, this species has been recorded from various localities in Australian, Indo-Malayan and Neotropical Regions of the world. From the Indo-Malayan Region, it has been recorded as follows: Sri Lanka; Java and Philippines (Snyder 1949); Khulna, Bangladesh (Choudhry 1955); ANDAMAN ISLANDS: Maya Bunder and Ross Is. (Roonwal & Bose 1970; Chhotani 1970); Barkuda Island, Chilka Lake, Orissa (Roonwal & Sen-Sarma 1956); J. Plot, 50 Km. North-East of Nankhana Range Headquarters (West Bengal) (Sen-Sarma & Mathur 1957), Daman (Chatterjee & Thakur 1968); Begna, Gosaba, Sazanakhali Forest Station and Tuskhali, Rampura Range Headquarters (West Bengal).

4. **Cryptotermes havilandi** (Sjöstedt)

Bioecology:

Cryptotermes havilandi has been recorded in its native habitat from the eastern countries of Africa and rain forests of the Congo Republic, where it is widely distributed in wild habitat, occurring, in living branches, dead and dry parts of living trees, stumps and logs,

but rarely in man-modified environments. The first record of the invading of human habitations by this species was in Africa in 1872, where alates were observed emerging from a dead wood, completely riddled by this species (Gay 1970). Like other drywood termites, this species has also enlarged its range of distribution to various zoogeographical regions of the world through introduction. Moszkowski (1955) and Chhotani (1963, 1970) have recorded this species as widely distributed in India and Bangladesh, occurring in wild state in far interior of the country, some hundreds of kilometres from coastal region. This view has, however, been rejected by many workers (vide supra under *C. bengalensis*). Obviously the material on which their conclusions were based, was collected in wild habitat in Sunderbans and Mandla Fort (M.P.) and actually belonged to the native species *C. bengalensis* Snyder. Though exotic species are able to successfully invade native habitats (semi-wild situations) in island communities with an impoverished fauna, they always fail to penetrate beyond the regions of offshore islands, mangrove swamps of continents, probably because of greater competition from closely related native species (Gay 1967, 1970). There are no published records of an introduced species having adapted and established itself in the natural habitat in the far interior of a continental land mass. Therefore, I fully agree with the view of Gay and other workers in this respect.

Roonwal and Bose (1970) and Chhotani (1970) have reported this species from a dead log on ground and a dead standing tree in Andaman Islands. Its absence at the moment in Nicobar Islands is probably due to inadequate collections from these Islands and calls for more extensive survey of these areas.

Distribution:

It is widely distributed species and has been recorded from Ethiopian, Malagassy, Neotropical and Oriental Regions. From the Indo-Malayan Region, it has been reported from the following localities: BANGLADESH: Dacca. SRI LANKA: Balangoda; Chilaw; Peradeniya; Paiyagoda near Kalutara; Puttalam and Tlalwila. India; ANDAMAN ISLANDS: 2 Km. inside the forest Laitora, Little Andamans; Taibalowe, 16 Km. east of Ingoe and Otirubera Korale, 17 Km. west of Ingoe (Little Andamans) (Chhotani 1970 and Roonwal & Bose 1970).

5. **Cryptotermes roonwali** Chhotani

Bioecology:

This is another native species and like its sister species, *C. bengalensis,* nests primarily in dead and dry portions of living trees in wild habitat. Its recorded hosts are *Ficus religiosa* and *Syzygium cumini*. The attack though extending to the living tissues of the host, does not go deeper. From the collections made at various places, it has been observed that this species prefers to nest near the human habitations, which may be in the thick forests quite far away from the cities. The fecal pellets are small blackish brown and oval in shape. This is probably the same species which was collected by Assmuth (1913). Though not recorded so far from man-made structures, but the possibility of its becoming a serious domestic pest at a later date, cannot be ruled out, as has been observed in case of *C. bengalensis* Snyder (vide supra).

Distribution:

This species appears to be widely distributed in south India and has been recorded from the following localities: KARNATAKA: Anekad Range; Bangalore; Chickmagalur; Dharwar; Megalapura near Mysore and Tellagatpur near Bangalore. KERALA: Malabar.

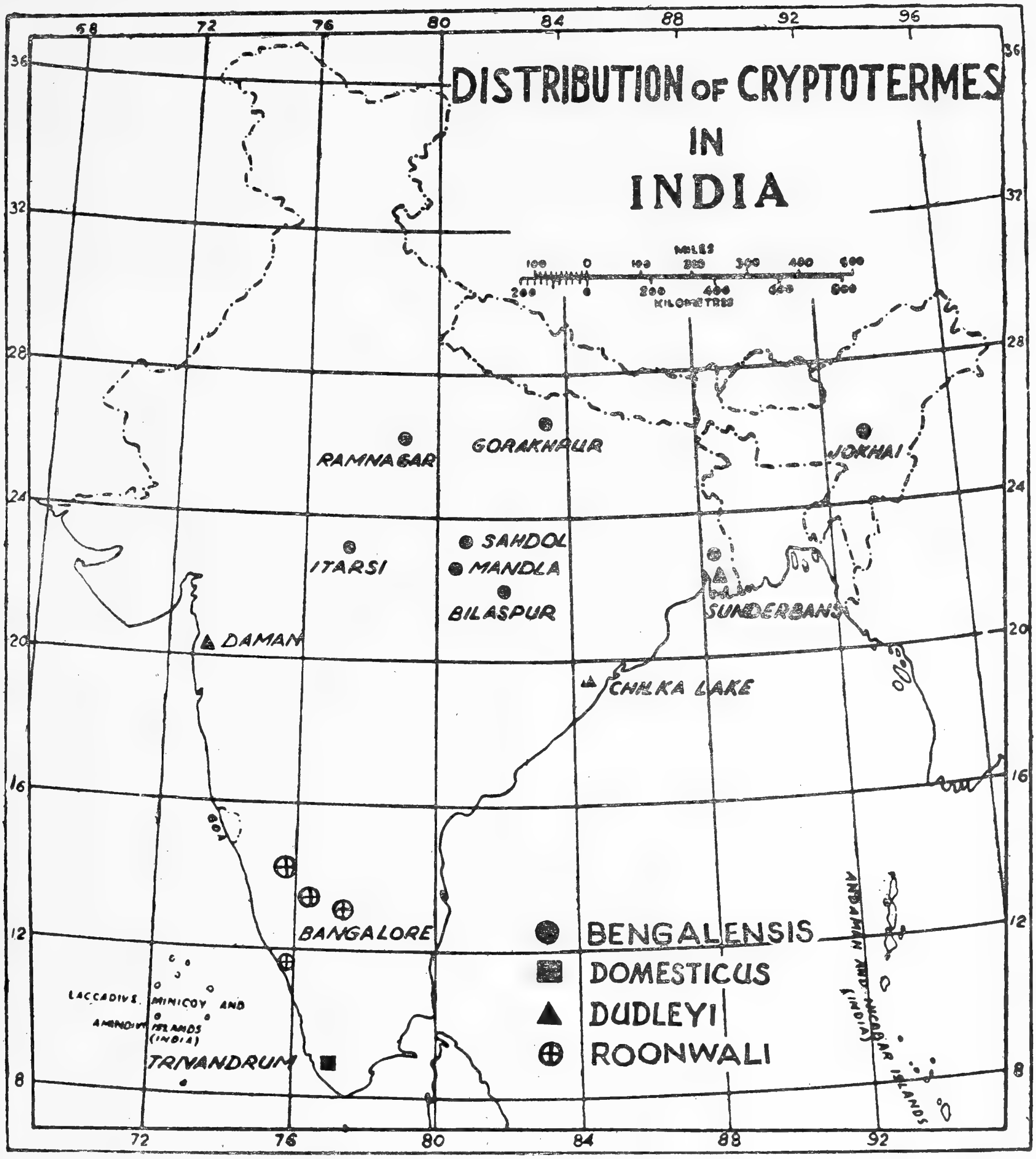


Fig. 1. Map showing the distribution of species of major wood destroying termite genus *Cryptotermes* in India.

(Note: *C. havilandi* not shown in the map.)

TABLE 1

DISTRIBUTION OF SPECIES OF TERMITE GENUS *Cryptotermes* IN THE INDIAN REGION

Species	Distribution	Authorities	Host, if any
Cryptotermes bengalensis Snyder	ASSAM: Jokhai Reserve Forest, Lakhimpur.	Roonwal & Pant (1953) Roonwal & Chhotani (1962) Chhotani (1963, 1970)	*Carapa moluccensis* var. *gangetica*
	MADHYA PRADESH: *Bilaspur*: Surhi Village (Lormi Range). *Hoshangabad*: Kesla Range. *Sahdol*: Jaisingh-nagar. Mandla Fort.	Sen-Sarma & Thakur (1974)	*Adina cordifolia* *Ficus benghalensis* *Mangifera indica*
	UTTAR PRADESH: Gorakhpur, Ramnagar.	Sen-Sarma & Thakur (1974) Sen-Sarma *et al,* (1975)	*Mangifera indica* *Artocarpus heterophyllus* and
	TRIPURA: *Agartala*: Balonia and Paratia.	Sen-Sarma & Thakur (1974) Sen-Sarma *et al,* (1975)	*Shorea robusta*
	WEST BENGAL: Sunderbans.	Snyder (1934), Beeson (1941) & Chhotani (1963, 1970)	*Erythrina indica* *Heritiera minor*
Cryptotermes domesticus (Haviland)	KERALA: Travancore, Trivandrum.	Snyder (1934) and Chhotani (1970)	Wood-boat model of *Mangifera indica*
Cryptotermes dudleyi Banks	ANDAMAN ISLANDS: Maya Bunder and Rose Island.	Roonwal and Bose (1970) & Chhotani (1970)	Log of wood and dead standing tree
	DAMAN: P.W.D. Rest House.	Chatterjee & Thakur (1968)	Wooden poles
	GOA: Nova Goa. KERALA: Cannanore (Western Coast).	Cherian & Margabandu (1944) Chhotani (1970)	
	ORISSA: Barkuda Island, Chilka Lake.	Roonwal & Sen-Sarma (1956)	
	WEST BENGAL: J. Plot 30 miles NE of Nankhana Range. Jhigakhali (Sunderbans).	Sen-Sarma & Mathur (1957) Chhotani (1970)	Wooden poles, pillars, doors, windows & all types of bamboos
Cryptotermes havilandi (Sjöstedt)	ANDAMAN ISLANDS: Laitora (7 km North of Tokibuea): *Little Andamans*: Taibalowe & Otirubera	Roonwal & Bose (1970) Chhotani (1970)	Log of wood and dead standing trees
Cryptotermes roonwali Chhotani	KERALA: North Malabar.	Chhotani (1970)	
	KARNATAKA: *Bangalore*: Anekad Range, *Dharwar*: Megalapur near Mysore and Tellagatpur near Bangalore.	Assmuth (1915), Chhotani (1963, 1970)	*Ficus religiosa* and *Syzygium cumini*

Discussion and Conclusions

From the foregoing account, it will be seen that the species of genus *Cryptotermes* belong to an economically important group of wood-destroying termites. There are two categories of dry-wood termites, namely introduced species and native species. It has been observed that introduced species are strictly restricted to the coastal areas and cause serious damage to the wooden structures in buildings, thus posing a potential danger to man-made structures in the country of introduction. The ability of these termites to tolerate very low moisture conditions for a long period and the small size of the colony, which can be lodged in small wooden articles, make them ideally suited for easy transportation and introduction in new habitats (Gay 1967, 1970).

Introduction of species of this genus from one country to another (e.g. *domesticus, dudleyi* and *havilandi*) or from one locality to another in widely separated areas within a country (e.g. *bengalensis* and *roonwali*), most probably takes place through transportation of infested materials. These termites therefore, pose serious external and internal quarantine problems. Quarantine legislations are in vogue in several countries to check the introduction of these powder post termites. Introduced species, however, are not able to radiate into the different ecological niches in the country of introduction, probably due to severe biotic barriers of closely related native species. These barriers are strong in continental areas, but relatively weak in island communities, where exotic species are able to successfully invade the native habitats with an impoverished fauna (Gay 1967, 1970).

The fact that *C. bengalensis* has successfully invaded "Man-modified environment of houses" in close neighbourhood of its wild habitats in Assam and Tripura, is a warning that *C. bengalensis* in Madhya Pradesh and Uttar Pradesh and *C. roonwali* in south India may become a domestic pest at a future date.

The geographical distribution of species in India (Fig. 1; Table 1), show a definite pattern. Among the native species *C. bengalensis* is primarily restricted to wild habitats in Assam, Madhya Pradesh, Tripura, Uttar Pradesh and West Bengal. *C. roonwali* is a peninsular species, occurring in Karnataka and Kerala States. The introduced species are restricted to the coastal regions only. *C. domesticus* is found only in man-made structures in Kerala. *C. dudleyi* has a much wider distribution along the eastern and western coasts of India, Bangladesh and Sri Lanka. *C. havilandi* does not occur anywhere in the main continental land mass of India. It has, however, been reported from dead log and dead standing trees in Andaman Islands. It is however, not certain as to when and how it was introduced in these Islands.

Not withstanding all these contributions made so far, it must be admitted that our knowledge of bioecology, habits and distribution of drywood termites is far from satisfactory. For example, no information is available on the time of swarming and flight range of winged forms, on which the trapping operations as a control measure depends. This calls for more intensive research on these lines for this group of termites.

References

AHMAD, M. (1965): Termites (Isoptera) of Thailand. *Bull. Am. Mus. nat. Hist. 131*: 1-114.

ASSMUTH, J. (1913): Wood-destroying white ants of the Bombay Presidency. *J. Bombay nat. Hist. Soc. 22*: 372-84.

CHATTERJEE, P. N. AND THAKUR, M. L. (1968): On a collection of termites from Daman. *Indian For., 94*: 562.

CHHOTANI, O. B. (1963): The termite *Cryptotermes havilandi* (Sjöstedt) from the interior of India. *J. Bombay nat. Hist. Soc., 60*: 277-78.

———— (1970): Taxonomy, Zoogeography and Phylogeny of genus *Cryptotermes* (Isoptera: Kalotermitidae) from the Oriental Region. *Mem. Zool. Surv. India. 15* (1): 1-81.

CHOUDHRY, G. U. (1955): Notes on a collection of termites from Pakistan. *Pakistan J. For., 5* (1): 40-43.

GAY, F. (1967): A world review of introduced species of termites. *Bull. Commonwealth Sci. Industr. Res. Organ.*, Melbourne, *286*: 1-88.

———— (1970): Species introduced by man. In "Biology of Termites" vol. II: 459-494. Ed. Krishna & Weesner (Akademic Press, New York).

HOZAWA, S. (1915): Revision of Japanese termites. *J. Coll. Sci. Imp. Uni.*, Tokyo, *35*: 1-61.

MATHUR, R. N. AND THAPA, R. S. (1962): A revised catalogue of Isoptera (White Ants) of the Entomological Collection at Forest Research Institute, Dehra Dun. *Indian For. Leafl.*, New Delhi, No. *167* (Ent.): 1-122.

———— (1965): Termites of Assam, with description of three new species. *Bull. Ent.*, Madras, No. *6*: 1-14.

MOSZKOWSKI, L. I. (1955): *Cryptotermes kirbyi* new species from Madagascar and *C. havilandi* (Sjöstedt) from Africa and introduced into Madagascar, India and South America (Isoptera: Kalotermitidae). *Mem. Inst. Sci.*, Madagascar (E), *6*: 15-41.

ROONWAL, M. L. AND BOSE, G. (1970): Taxonomy and Zoogeography of termite fauna of Andaman and Nicobar Islands, Indian Ocean. *Rec. Zool. Surv. India. 62* (3-4): 109-170.

ROONWAL, M. L. AND CHHOTANI, O. B. (1962): Termite fauna of Assam. *Proc. Nat. Inst. Sci. India*, (B) *28* (4): 281-406, 24 Pls.

ROONWAL, M. L. AND PANT, G. D. (1953): A systematic catalogue of the main identified collection at the Forest Research Institute, Dehra Dun, Pt. 9 (*Isoptera*). *Indian For. Leafl.* (*Ent.,*). New Delhi, No. *121* (3): 39-60.

ROONWAL, M. L. AND SEN-SARMA, P. K. (1956): Systematics of Oriental termites (Isoptera), No. 3. Zoological Survey of India Collection from India and Burma with new species of the genera *Parrhinotermes, Macrotermes, Hypotermes* and *Hospitalitermes*. *Indian J. agric. Sci. 26*: 1-37.

SEN-SARMA, P. K. AND MATHUR, R. N. (1957): Further records of occurrence of *Cryptotermes dudleyi* (Banks) in India (Insecta: Isoptera). *Curr. Sci. 26*: 399.

SEN-SARMA, P. K. AND THAKUR, M. L. (1974): Biology, distribution and economic importance of some termites attacking buildings. *IPIRI J.* Bangalore *4* (3): 115-25.
(Paper presented at the Symp. Quality, Construction and Cost aspects of Building Timbers and Timber structures. 1st-3rd June 1972, Dehra Dun, organised by N.B.O.).

SEN-SARMA, P. K., THAKUR, M.L., MISRA, S. C. AND GUPTA, B. K. (1975): Studies on wood-destroying termites in relation to natural termite resistance of wood. Final Tech. Rept. PL 480 Project A-7-58 (1968-73), Dehra Dun: 1-187.

SNYDER, T. E. (1934): New termites from India. *Indian For. Rec. 20* (11) (Old series): 4-6.

———— (1949): Catalogue of termites (Isoptera) of the world. *Smiths. misc. Coll., Washington, 112*: 490.

OBSERVATIONS ON THE BIOLOGY OF THE PIGMY HOG (WITH A FOOTNOTE ON THE HISPID HARE)[1]

Pigmy Hog Survey, 1977—Part II

William L. R. Oliver[2]

(*With two plates and three text-figures*)

Introduction

This paper represents the second part of a general report based on a pigmy hog *Sus salvanius* field survey that was undertaken in north-western Assam in the period late March to mid-June 1977. The study was jointly instigated and financed by the Assam Valley Wildlife Society and the Wildlife Preservation Trust and had the full co-operation of the Assam Forest Department. It had two primary objectives which were to investigate the biology of the species in the field and to analyse population trends and pressures in view of their evident continuing decline. The second of these objectives has already been considered at some length in the first part of the report which deals with their conservation (Oliver 1978) and this part is therefore, primarily concerned with the biology of the species from both the wild and captive populations.

Whilst this survey was of admittedly short duration, its timing was determined by the relative frequency of sightings during this period which occurs between the burning of the dry season habitat in late January and February and the regrowth of vegetation in May and June following early rains. This did in fact prove fortuitous for the analysis of population pressures as outlined in the conservation report, and to some extent also facilitated field study by isolating remnant populations in small patches of unburnt habitat. However, the increases in reported sightings in this period actually relate mainly to animals escaping from the burning or those displaced by it onto surrounding cultivated land, e.g. tea estates; and actual 'in situ' field sightings remain infrequent. This is hardly surprising in view of the small size and secretive nature of the species, and its observationally unsuitable habitat which is comprised of mixed high scrub and thatching (elephant) grasses. This habitat is very dense and even though the vegetation is shortest at this time, it still averages a height of two or three metres. Even in the dry season therefore, these factors renders sustained ethological observations out of the question and led Ranjitsinh (1972) to state that "satisfactory observation of their habits is impossible in the wild."

To a large extent this is true, for the only direct sightings made were occasional chance glimpses, despite attempts at sustained obvervation in known habitation areas during known activity periods. This clearly explains our poor knowledge of the species in the wild and lends plausibility to the once growing fears of their possible extinction. It is also reflected in the incompleteness of field data that was collected, though field research does not rely entirely on direct observation, for much can be learnt about their ecology and behaviour from physical evidence of their activity. Nevertheless, it has been necessary to rely heavily on observation of the behaviour of captive animals and the collection of incidental accounts from a wide variety of sources, including some previously published infor-

[1] Accepted April 1978.

[2] Jersey Wildlife Preservation Trust, Les Augres Manor, Jersey, Channel Islands.

mation, so that generalisations about biology can be formulated. Accumulated data thus becomes quite extensive, though some aspects remain unknown or poorly understood, and some assumptions are speculative as there is clearly a limit to extrapolation from captive studies as these are to some extent out of context with behavioural motivation and adaptive function.

The first report on conservation also considered the hispid hare *Caprolagus hispidus*, as the two species are both rare, sympatric and closely associated with respect to their recent history, and much of the information relating to habitat and conservation is equally applicable to both species. Some information is also presented here in a footnote on the behaviour of the hare, though observations in this case are essentially incidental to the main species study. It is also worth noting that whilst it has proved necessary to treat the two aspects of conservation and biology separately for both species, it is clear that they are closely interrelated and there is, therefore, some inevitable overlap in the data presented in the two reports, though attempts have been made to reiterate information as little as possible.

Methods and study sources

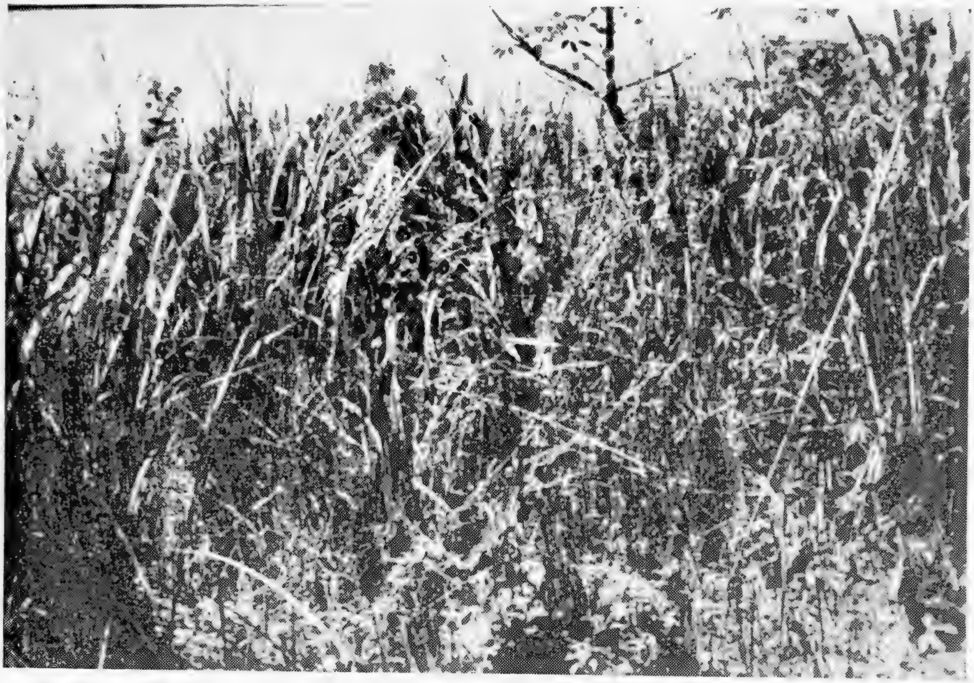
Given the predictable difficulties of direct field observation owing to the nature of the study species and of its habitat, behavioural data inevitably stems primarily from captive stocks. At the time of study in Assam, these comprised 2♂♂ 3♀♀ pigmy hogs at the Assam State Zoo, Gauhati and 3♂♂ pigmy hogs at Pertabgur Tea Estate, Darrang.* In the event, neither of these groups proved to be particularly suitable for study purposes, though observations from these, together with discussion and appraisal of stock records and correspondence files, represents a major source of behavioural material.

Considering firstly the Gauhati Zoo hogs, these were subject to a 48-hour continual surveillance undertaken jointly with I. K. Bhattacharyya** with a view to determing circadian activity and general behaviour patterns. Nocturnal observations during this period were facilitated by the timing of the study period to coincide with full moon and the use of a torch equipped with a red filter, to which the animals were relatively insensitive. The zoo authorities were very co-operative but direct access to their stock was limited owing to the extreme nervous disposition of the animals themselves, rendering close proximity abortive as it led to disruption of activity through panic or concealment. Most observations made actually relate to a sub-adult pair born in May 1976 as the adult trio were separated into a small area of the enclosure owing to the recent introduction of a new adult male on loan from Pertabgur. These adults were almost impossible to observe in any detail except at close quarters, but this was again curtailed by the extreme nervousness of the females. Space limitation and the highly unsatisfactory nature of the separation area anyway precluded most normal activity.

By contrast, the enclosures for the boars held at Pertabgur were ideally suited to these animals being of large size and for the most part comprising a high (guatamala) grass bari. This heavy cover also necessitated very close proximity for observations though this purpose was also partly frustrated by the virtual cessation of all other activity on human approach by the animals extreme tameness and their continual efforts to solicit grooming.

* These animals have since died (J. G. Oliver, in litt.)

** Lecturer in Zoology, Cotton College, Gauhati.



Above: Typical unburnt thatch-scrub which is the prime habitat of both pigmy hog and hispid hare. *Below*: Nest of wild pigmy hog.

Above: Adult female hispid hare captured in Barnadi Reserve Forest in April 1977.
Below: Demarcation site of wild hispid hare with characteristic thatch cuttings and faecal deposits.

This human orientation was of course exacerbated by the preclusion of normal social interactions by virtue of the sex ratio and the necessity for permanent separation, though all three boars had been previously maintained at intervals in group situations.

The main field study area was the Barnadi Reserve Forest in the Rajagarh area of Mangaldai, Darrang District. This locality was an obvious choice as it is one of the few areas where pigmy hog were definitely known to occur as it had been the source of the original, and nearly all subsequent captive stocks (see Part I for a detailed description of the area). Preliminary field research essentially consisted of random screening for behavioural indicators for the selection of specific study areas and to determine habitat preference. In the Barnadi Reserve Forest available habitat proved to be so restricted that further selection was unnecessary as all habitation areas could be screened at intervals. The determination of pigmy hog activity was primarily by means of the distinctive forage marks resultant from rooting with their snouts that is so typical of Suids. These excavations deteriorated quite quickly so it was easy to determine activity as being recent or very recent. Nests were also used as indicators and whilst fresh nests are obvious, old nests deteriorate only slowly and so it is quite possible that some of the nests found were several weeks old and are therefore unreliable indicators of current activity. Moreover, nests were very difficult to find and it would be necessary to carefully and comprehensively screen an entire area to conclusively negate habitation. By contrast, forage marks are easy to find and generally speaking even superficial screening will quickly prove or negate recent activity. Pigmy hogs leave no discernable trails or footprints, at least during the dry season, and no obvious faecal deposits or other demarcation evidence was ever found.

Many attempts were made at stationary observation at recent or otherwise likely forage sites during known activity periods particularly shortly after dawn or at dusk. These proved fruitless for it appeared that choice of foraging areas was randomised and unpredictable and owing to the nature of the habitat only small areas could be surveyed and therefore only very good fortune would yield even short period chance observation. Attempts were also made at baiting selected sites, though this was eventually abandoned as it proved impossible to maintain regular baiting owing to poor weather conditions rendering access roads impossible. It was clear that baiting for hide observation would have to be sustained for some considerable period as even an odd chance encounter with bait was rendered less likely by their forage and obvious scarcity even in prime habitat.

It had become clear early in our consideration of possible methods of approach that radio-telemetry could have very definite application in this situation, particularly for the determination of home range and circadian activity. In the event it was only possible to capture and mark two pigmy hogs owing to our permit requirements consequent of Assam's recent ratification (in January 1977) of the 1972 Indian Wild life (Protection) Act.

Owing to the streamlining of the animal's body, it was necessary to design a harness rather than a simple collar. The harness is described in detail as it contains some innovations which may be of interest. SB2 (Max range) 2.7V transmitters manufactured by AVM Instrument Co. operating on 150.721—150.834 MHz were used with two 1.4V Mallory Duracell batteries type RM601TZ. This gives a short life/long range combination ide-

ally suited to the purpose and it was found that effective field range was approximately $1\frac{1}{2}$ miles in this type of habitat using an LA12 Receiver also manufactured by AVM. The problems of possible endothermic heat damage during encapsulation were overcome by first embedding the transmitter and batteries in silicone rubber caulk prior to final encapsulation in clear epoxy resin (see Fig. 1). The justment was derived by cutting the strip opposing each fixed length (i.e. optimum 20 cm and 30 cm harness/antennae strap). The adjustable portion of each strap was thus cut to size in the field, secured with nylon fishing line by means of holes punched in the feeder cable between wires and cemented with cynoacrylate contact adhesive ('Permabond'). This gave an almost and permanent join that

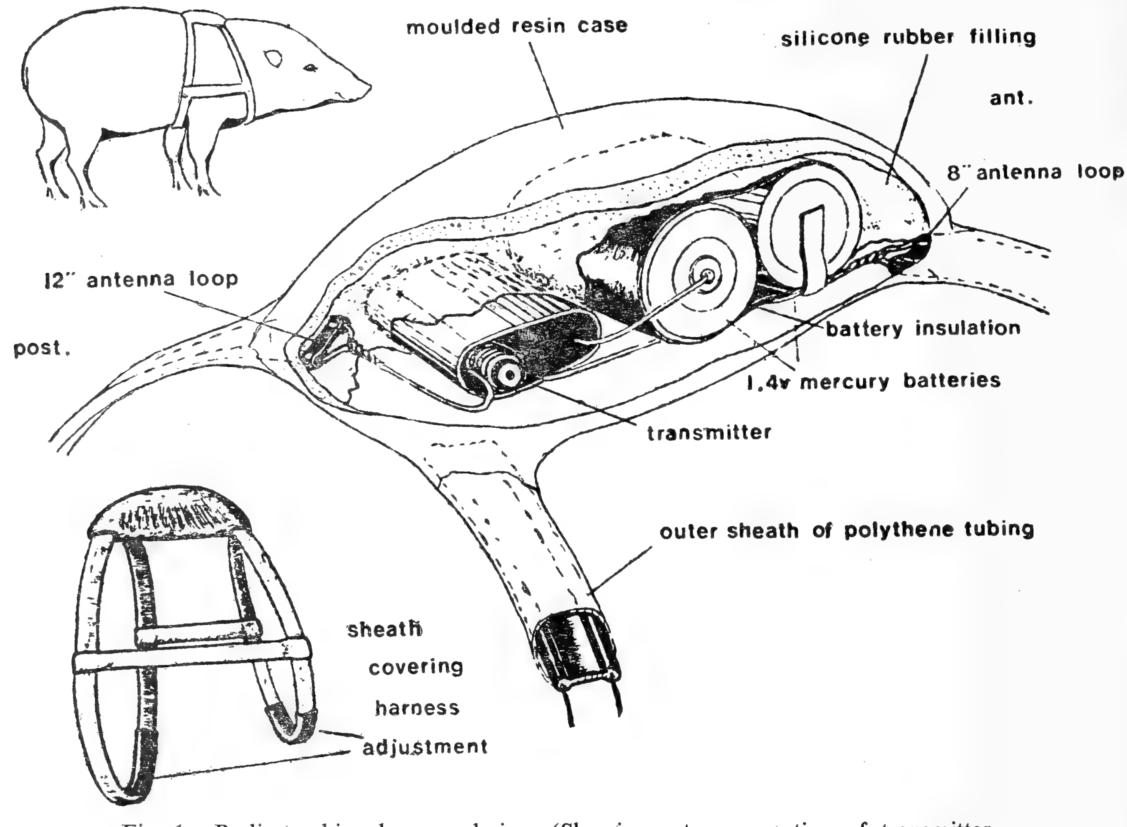


Fig. 1. Radio-tracking harness design. (Showing cut-away section of transmitter capsule and completed and fitted harness.)

transmitter capsules were streamlined to minimise impedence through thick vegetation.

The harnesses were constructed of 300 ohm twin feeder cable providing twin antennae loops and great tensile strength. Harness adwas quickly adjusted and fixed. The whole harness was sheathed in P.V.C. tubing to minimise abrasion and waterproof the harness, and render the harness conspicuous in the event of a chance encounter. The whole har-

ness and transmitter module weighed 140 gm. equivalent to $\pm$ 1/50 or 0.05 of total body weight of marked animal.

The two animals were caught by means of a drive using beaters to direct the animals into nets arranged along an elephant track. We were forced to use this method as live trapping was unlikely to be successful in the absence of clearly discernable trails. Despite this, considerable difficulties were met with actually capturing the animals owing to the fact that they split up when disturbed and moved at astonishing speed in widely differing directions. In order to gain as much information as possible from the drives themselves, additional men were deployed as observers to count the number of pigmy hogs disturbed in each area covered by a drive. Each area driven was later measured and a crude estimate of animals per unit area was thereby derived. Eventually two sub-adult males weighing 7.1 and 7.2 Kg respectively were caught and harnessed by this means. It had been considered that animals might be anaesthetised for harness attachment but this was eventually rejected as it was thought that anaesthesia was probably of greater potential risk than brief physical retraint. Both specimens were weighed, harnessed, photographed and released within about ten minutes of capture.

It is interesting to note that when captured the animals struggled wildly and squealed, but made little attempt to bite and restraint was easily accomplished by a single person holding the scruff of the neck and the hind limbs to prevent kicking. The species supposed ferocity (Mallinson 1971 and 1977, op cit. Hodgson 1847) is loosely based and considerably exaggerated.

For the purposes of actual radio tracking, landmarks in the form of three distinctive trees for each animal, were chosen as compass bearing points for triangulation and marked with coloured cloth. The live marked animals were approximately 1½ mile apart so could not be monitored simultaneously. The animals were tracked from elephant back as it proved physically impossible to travel on foot quickly between bearing points in the dense vegetation to take meaningful readings at frequent intervals. The use of an elephant also provided additional height thus affording better reception and reducing human noise which may bias the animals' movements. The animals were monitored in shifts at half hourly intervals from each bearing point.

Unfortunately, radio tracking was also disappointing and by no means realised its expected potential. There were several reasons for this, not least of which was that both specimens only retained their harnesses for relatively short periods. The first animal lost its harness after only 12 days and on recovery was undamaged so it must have been fitted too loosely. The second animal escaped from its harness after 17 days by breaking at a point where the aerial loop enters the transmitter capsule. These faults could not be rectified as it was not possible to capture further animals owing to our permit restrictions. Moreover, the onset of appalling weather conditions actually prevented the monitoring of these animals for much of the short period during which they retained their harnesses, as it became physically impossible to get access to the Forest Reserve as approach roads and a river 'en route' became impassable. Only a few hours transmissions were actually monitored for the first animal and a few days for the second and though some conclusions can be derived from these, the results are not nearly as satisfactory as desirable. Some other problems associated with radio-tracking in this habitat are also worth mentioning. Clear-

ly there is no advantage to be gained from homing in on a marked animal as they remained concealed even at close proximity and such a move would undoubtedly influence their movements. Results were therefore plotted on a ground plan of the area, but again it was not possible to return later to a specific area in order to ascertain what the marked animal had been doing at a certain given time for the bearing points for triangulation were quickly lost to sight in the forest plantations.

A further source of certain data stems from two freshly killed males that were offered to me for sale by local hunters. For obvious reasons it was not possible or advisable to purchase these animals though some overt measurements, tissues, faeces, stomach contents and ectoparasities were removed. A good deal of new information was also found to be readily available from local people that stems from hunting, forestry operations and chance observations and as much of this first hand information as possible was collected from villagers, forest officials, plantation workers and shikaris. Attempts have been made to appraise and collate this data objectively and it is worth noting that whilst local opinions about the species may differ widely from one another, actual observations are remarkably consistent.

Habitat

The former and present known distribution of this species can be exclusively equated with the availability of the tall-grass savannah that typically occurs along the southern edge of the Himalayan foothills. Essentially this habitat is flat, well-drained and thinly forested. In its natural state it comprises a mixed dense scrub-jungle that is characterised by the tall thatch or elephant grasses (Plate I). To the north this gives way quite suddenly to the deciduous and evergreen forest of the hill slopes but southwards there is a less obvious transformation to the lower lying savannah that is subject to sustained flooding during the monsoon. Recent records of pigmy hog invariably relate to areas that are not normally subject to extensive waterlogging. The former distribution of the species is not clear cut for records are dependant on occasional chance observation, shikari accounts and hearsay, though neither species has ever been reliably recorded from typical lowland savannah possibly indicating poor migratory ability. The species was formerly widely, but possibly discontinuously, distributed along the foothills from N.W. Assam, through parts of Bhutan, North Bengal and Sikkim to Southern Nepal. Unlike the otherwise sympatric hispid here, the species has never been recorded as far west as Uttar Pradesh. The distribution of both species is limited eastwards by the disappearance of the thatchlands in the region of North Lakhimpur with an increasing abundance of evergreen forest and heavier rainfall (See Part I for distribution map).

The highland and lowland savannahs have been increasingly settled and converted to paddy cultivation so that very little natural savannah remains. Moreover, most of the remaining savannah falls under the control of the State Forest Departments and is further degraded by commercial species plantations and thatch harvesting (thatch mahal). The most important factors controlling the floral and faunal composition of these regions are dry season burning in both classes of savannah and the prolonged inundation during the monsoon of the lowland savannah. The profound and ecologically disastrous effects of dry season burning have already been considered in some detail (Part I) and apart from

encroachment, this is undoubtedly the single most important factor affecting the remaining habitat and future of these animals. The differing fire resistances of plant species has favoured the varieties of elephant grasses so that the naturally rich and diverse scrub jungle has been impoverished and distorted so that most areas now comprise a relatively uniform high grass biotope. The blanket term 'elephant grass' actually included many varieties some of which are strictly reeds and are unsuitable for thatch purposes. The most important and widespread genera of true thatching grasses are *Themeda, Saccharum* and *Phragmites* sp. and various species of these tend to dominate the remaining available habitat. Collectively these grasses are known as 'kher' (or 'khagri') in Assam (hence 'kher bari' the assamese name for the thatchlands) or 'ikra' (or 'ekra') by the Rhabha and Garu tribes (D. K. Lahiri-Choudhury pers. comm.) and 'nul' (or 'nal') in Bengali*. Various other important herbaceous plants are also typical and have proved resistant to the fire hazard, notably the perennial 'argeretum' *Lantana camara* (very common in Barnadi), the ubiquitous 'German plant' *Eupatorium odoratum* and *Lea robusta* (common in Manas). (See Appendix I for a preliminary list of species in the Barnadi Reserve Forest). Another species, wild cardamom, sometimes associates with thatch in relatively moist areas (e.g. in Nandaur Reserve Forest) and pigmy hogs have several times been reported from mixed thatch and tara (=cardamom in Bengali) jungle (K. Hatibarau pers. comm.).

Much of the highland savannah is lightly forested, though natural secondary forest or mature light mixed deciduous and evergreen forest tends to occur in discontinuous patches. It is not immediately clear how much savannah forest has been modified by human activity or how extensive it was formerly. Areas left unburnt are quite quickly, but lightly, reafforested with fast growing species such as simul, sishu and khier and it is apparent that this process does not preclude the dense scrub undergrowth as has been argued by advocates of regular burning. Indeed most of the thatch mahal areas in Reserve Forests have been reafforested with fast growing commercial softwood monocultures.

* Hence the Bengali name for pigmy hog 'nul gowri' (grass pig), though in Hindi it is known as 'chota-suar' (little pig).

Population density and home range

The density of pigmy hogs per unit area of populated habitat that was deduced by counting the animals disturbed during the drives, was actually estimated from three separate drives covering a total area of 47.3 hectares. These disturbed 3, 6 and 0 pigmy hogs respectively, or an average of one pigmy hog/5.34 hectares. As these drives are obviously disruptive they were to some extent randomised and widely spaced, though it is important to note that the general shortage of habitat and the small size of the remaining patches of unburnt jungle (with the consequent human disturbance and hunting pressure) must influence population levels. Moreover the loss of cover must be critical for although the population is undoubtedly at its lowest during April (before the late April/May birth peak) the spacial requirements of the animals will also be relatively high and proportional to resources being at their lowest towards the end of the dry season.

The only figures available for home range stem from the short term monitoring of the

second radio-marked male. This animal was not free ranging within the monitored period, and its movements were restricted to one part of a relatively large habitat patch of 83.5 hectares. All radio fixings recorded from this animal from original screening following capture to the recovery of the broken harness, were plotted and cover a single continuous area approximately 26.5 hectares in extent. It is probable, though by no means certain, that this animal was part of a family group or sounder. It is unfortunate that no direct observations were possible subsequent to capture, as sociality is obviously of the greatest

APPENDIX 1

PRELIMINARY LIST OF PLANT SPECIES IN THE BARNADI RESERVE FOREST

CLASS	SPECIES	LOCAL NAMES
Low grasses	*Cyperus rotundus*	motha
	Commelina bengalensis	konasimolu
	Cynodon dactylon	duboribon (the tuber of this grass is eaten by pigmy hog)
Tall grasses	*Saccharum munja*	barenga
	Saccharum spontaneum	kahibon
	Phragmites karka	khagori
Shrubs	*Eupatorium odoratum*	german plant*
	Lantana camara	argeretum
	Tamarix dioica	jhau bon
	Calotropis gigantea	moder
Undergrowth	*Alocasia indica*	mankachu
	Abutilon indica	japapetari
	Abroma augusta	bonkopahi
	Blumera lacera	kukurshuta
	Mimosa pudica	nilaji bon
	Solanum ferox	bon bengena
	Solanum indicum	tita bhekuri
	Dioscorea alata	pani aloo
	Ranunculus sp.	
	Salvia sp.	
Tree	*Acacia catechu*	khoir
	Casuarina equisetifolia	jhau
	Acacia arabica	torua condom
	Ficus glomerata	dimaru
	Bombax malabarica	simul
	Dillenia indica	auoo tenga
	Anthocephalus indicus	kadamba
	Barringtonia acutangula	hidal

* Introduced species (N.B. Also some exotic Eucalyptus and Teak plantations).
From data compiled by I. K. Bhattacharyya and Cotton College, Gauhati.

significance to spatial requirements. However, if we assume an average sounder composition of five individuals for this time of year (see Social Behaviour), this figure actually produces remarkably similar results i.e. one pigmy hog/5.255 hectares, to that obtained independently for estimated population density of one hog/5.34 hectares. Both methods are admittedly rather crude and rely on very small samples and a number of undetermined variables, but it does give some indication of density from which it is possible to extrapolate overall population of a given area simply by measuring the amount of total populated habitat (for Barnadi see Part I). It also has profound and obvious significance for the future of the species in respect of the size of areas required to be left unburnt in order to sustain viable populations during the dry season.

Social behaviour

Whilst discussing density and home range it is necessary to make the proviso that we cannot assume territorial behaviour and the mutual exclusion of other sounders from particular home ranges. The social units are undoubtedly cohesive and probably asocial to other groups and reports of large numbers of pigmy hogs, or even more than one group associating together, are extremely uncommon. However there is an evident lack of territorial defence or associated behaviour such as demarcation and this is typical of the simple social organisation of the Suidae (Ewer 1968). Even in adult boars, defaecation and urination is randomised and includes no ritualised behaviour or even inspection of deposits.

Pigmy hog social behaviour is in fact fairly typical in most respects of other *Sus* sp. as far as can be ascertained. The focus of social units is the female (or females) accompanied by the young of the previous season. Practically all first-hand observations of sounders stipulate a group size of four to six animals of varying sizes. Pairs have been reported only rarely, though conversely, as many as eight or even ten, have occasionally been seen together. The exception to this pattern are the many reports of single adult males which are probably solitary except during rut, and old males at least do not stay with the sounders permanently as suggested by Mohr (1960). Mature boars are readily distinguishable by their larger size, more robust appearance and well-developed tusks (or 'tushes') and are generally seen by themselves though they may associated loosely with female/sub-adult groups at other times of the year.

The differences in the observed size of social groups are, in part, related to seasonal reproductive behaviour and it must be borne in mind that most observations have been made during the January to April dry season period which falls between their winter rut and the onset of the breeding season at the beginning of the rains in late April and May. A pattern of reproductive-based changes in social behaviour is quite apparent both from captive observations and the incidental reports from the wild. Adult males join oestrus females during the winter rut in late December to early February and are undoubtedly disruptive to existing group composition by chasing away other males and possibly bringing together two or more females. Adult males have on occasion been maintained together peacefully in captivity in the tea estates but have become highly mutually intolerant and very aggressive during rut in January. J. G. Oliver (pers. comm.) has described the characteristic threat display and onset of fighting. The threat displays are typical of pigs and comprise a broadside stance

with head turning, yawning and curling of lips to expose tusks, champing of teeth and bristling of hair. This is followed by charging or violent rooting with their snouts to throw up earth. Fighting ensues if intimidation fails, but males that have previously been routed in a fight will squeal and run off merely on being threatened. It would seem likely that the disruption of sounders caused by the temporary association of oestrus females with breeding males would lead to the formation of bachelor groups, though unfortunately there are no records to confirm this. Contrarily it may be that the disruption is not permanent (at least for first year males) and that immature males rejoin females following rut. Certainly, observations of (displaced) sounders on tea estates in March and April following burning, usually comprised 2 or 3 larger animals accompanied by 2 or 3 smaller animals (D. J. Mukherjee pers. comm.) i.e. post-rut but pre-parturition. Observations on ten-month old juveniles at Gauhati Zoo demonstrated close maternal ties despite their physical separation by a wire fence owing to the introduction of the new mature boar. These young animals frequently approached their mothers' separation area and stood by it grunting softly. However, it is interesting to note that this behaviour was invariably initiated by the young animals (of both sexes) but was often not reciprocated by the dam. This may well be significant as these observations were made early in April when one can reasonably expect a lessening of sow's maternal ties in view of their next expected parturition at the end of that month. Moreover, this undoubtedly corresponds with puberty in young animals as evinced by the repeated attempts at copulation observed in 11 month old animals at Gauhati and Zurich Zoos in April. This may lead to successful (out of season) primiparous conceptions, e.g. Zurich (See Table 1).

It is therefore probable that the onset of farrowing itself is more disruptive to existing sounder composition (i.e. family groups) than is rut. The social unit of females with young of the previous season is maintained at least until this point, though it is unclear whether the pre-parturition groups are reformed after farrowing or even if sows actually separate to farrow as happens in wild boar *S. scrofa*.

However, these family groups are for the most part undoubtedly discrete and cohesive. 'Contact behaviour' is pronounced and animals always rest closely together both in and out of nests. They also forage closely together even in captivity and grunt softly to each other whilst rooting. This presumably serves to maintain group proximity in thick vegetation where even separation of a few feet will generally preclude visual contact. It was noticeable that even in open areas such as the large main enclosure in Gauhati Zoo, the animals invariably foraged together and if one animal moved off whilst the other was occupied the latter would quickly rejoin the former and resume rooting in the same vicinity. Mallinson (1971) has described how a group disturbed from a nest in captivity will run wildly but bunched together until alternative cover is reached where they pile on top of one another. Observations of wild hogs on tea estates indicate they also move closely together whilst travelling and usually in a regular order. Thus a typical sounder comprising (say) two adults and two or three juveniles always travelled in file with the adults assuming the foremost and hindmost positions (D. J. Mukherjee pers. comm.).

It is apparent that grooming, as well as being strictly utilitarian, is also socially cohesive. It is undoubtedly gratifying to the 'groomee'

who may frequently solicit grooming as is apparent by the behaviour of the tame boars at Pertabgur Tea Estate. Alternatively, grooming may be offered and the adult male at Gauhati Zoo was seen to approach a standing female and nibble at her rump until she lay down to be groomed. Grooming sessions occurred quite frequently in that adult trio, though the preclusion of many other activities (such as profitable foraging) by the poor quality of the separation area probably influenced its frequency. Male to female grooming sessions were much more frequent than vice-versa and the male always groomed in a standing position. The groomee always sits or lies down to be groomed and may even solicit grooming simply by lying down in front of a standing animal (e.g. female to male or male to keeper). The groomee lies on its side, lifts its legs to facilitate grooming, will roll over or even lie on its back. The longest grooming session observed at Gauhati Zoo lasted approximately eight minutes, though the boars at Pertabgur rarely tired of being groomed and sessions would usually last until the human groomer terminated them. These boars would tolerate grooming anywhere but would try and position themselves to be groomed under the chin or underbelly, groin and insides of thighs, i.e. they favour parts of the body that cannot be groomed by scratching with hind legs or by rubbing against vertical or other fixed structures. It was evident that male to female grooming sessions tended to be terminated by the female squatting on her hind-quarters if the boar concentrated unduly on rump or genitalia.

Reproduction

Most of the information that is available about pigmy hog reproduction stems from the captive breeding efforts of recent years and some aspects of this have already been comprehensively outlined by Mallinson (1977). Whilst it is therefore unnecessary to reiterate much of this information, parts of it have been summarised and reviewed below in the light of new information obtained.

As Mallinson has shown from births amongst captive animals between 1971 and 1976, the pigmy hog has a single and well defined breeding season that occurs in April and May in Assam. There were no captive births in Assam in 1977 owing to the loss of the breeding boar at Gauhati Zoo and the loss of the sows previously maintained at Pertabgur Tea Estate*. The only 1977 birth was therefore a litter born on 1st May to a pair from Pertabgur on loan to the Jersey Wildlife Preservation Trust and held at Zurich Zoo. Whilst this litter was also conceived in Switzerland, it still confirms the breeding season in Assam by virtue of their recent importation, i.e. in November 1976. This is significant as there may be a shift over a few years to a later birth peak in Europe, evident from four births recorded between 1883 and 1886 from animals once kept by the Zoological Society of London (see Table 1). Any comparisons between these births and the recent records in N. W. Assam is therefore of doubtful validity, particularly as the precise source of origin of the London Zoo stock is not known (as distribution is clearly important with regard to variances in seasonal factors influencing the timing of the breeding season).

Therefore if we discount the earlier births in the nineteenth century, all post-1971 births (with one notable exception—see latter text) fit neatly into this April/May seasonality.

* The Paneery and Attareekhat stocks were transferred to Pertabgur in 1976.

TABLE 1

CAPTIVE BREEDING OF *Sus salvanius*, DATE OF BIRTH AND LITTER SIZE. MODIFIED AFTER MALLINSON (1977). See text for explanation.

Litter No.	Date	Sex m	Sex f	Sex unsexed	Total	Location	Reared m	Reared f	Comment
1	23 May 1883			4	4	London Zoo	0		1 eaten by dam, 2 died in first two days
2	16 May 1884			1	?	London Zoo	0		Died after 2 days
3	11 Jun 1885			3	3	London Zoo	0		All died after 2 days
4	23 Jun 1886			1	?	London Zoo	0		Eaten by dam when 19 days old
1	28 Apr 1971	1	3	0	4	Attareekhat T. E.	0		Freshly caught, young only reared to 2-3 months of age
2	? Apr 1971				?	Attareekhat T. E.	0		Aborted soon after capture
3	24 Aug 1972			2?	2+?	Paneery T. E.	0		Partly devoured by dam, still born or post-partum death
4	24 Apr 1973	3	3	0	6	Paneery T. E.	3	1	Hand reared following death of dam, one runt which died at 3 days, 1 female died at 19 weeks
5	30 Apr 1973	2	1	1	4	Paneery T. E.	0		No nest constructed, dam neglected litter and all died within few days of birth, 1 eaten by dam
6	14 May 1974			3	3	Gauhati Zoo	0	1	One runt, sow reared to breeding age
7	? Apr 1975			3	3	Paneery T. E.	0		No record
8	? Apr 1975			3	3	Attareekhat T. E.	0		No record
9	10 May 1975			3	3	Gauhati Zoo	0		Eaten by predators (crow, mongoose or boar)
10	18 May 1976	2	1	0	3 (½F²)	Attareekhat T. E.	1	1	Primiparous birth from hand reared female, this animal later exported to Zurich Zoo
11	10 May 1976 }	2	2		3	Gauhati Zoo }	1	1	*2 eaten by crows post-partum
12	14 May 1976 }			3	4 (½F²)	Gauhati Zoo }			1 runt which died, 2 died at eight months
13	2 May 1977	4	1	0	5 (½F²)	Zurich Zoo	4	1	Only complete litter to be reared successfully
14	16 Sep 1978	1	1	0	2 (F²)	Zurich Zoo			Unborn full-term litter to sub-adult dam which died after caesarean section
Post 1971 total		15	12	18	43	born	9	5	reared

* The Gauhati Zoo litters born on 10th and 14 May were incorrectly listed by Mallinson as a single litter of six.

Moreover, it can be seen from Table 1, that this breeding season is not only clearly defined, but it actually only encompasses an approximate four week period. Thus over seven consecutive years breeding, the earliest and latest recorded parturitions were 24 April and 18 May respectively. It is unfortunate that not all tea estates parturitions are precisely dated, but the emerging pattern is still quite apparent.

The extremely high rate of infant mortality in captive animals is to be considered later, but there is one aspect of it that is significant in this context. As all the pigmy hogs have been acquired during the dry season, several of these births were conceived in the wild and the adults have been acquired in late-term pregnancy. Abortion or failure to rear full-term litters is hardly surprising under these circumstances and this may account for the exceptional birth on 24th August 1972. Unfortunately the history of this particular female is poorly recorded, though M. P. Singh-Sidhu (in litt.) noted that a female at Paneery Tea Estate who failed to rear the litter born to her on 30th April 1973 was observed to be mated again shortly afterwards. A subsequent pregnancy in this latter case was not recorded, though a post-partum oestrus is indicated if a litter is immediately lost.

This actually raises some very interesting questions on their sexual cyclicity about which there is still very little information available. Thus a testis collected from the wild adult male killed in Barnadi on 17th April showed no sign of spermatogenesis. Assuming that (post-rut) testis are normally inactive at this time, a mating in May (to account for the birth in August) must mean very long sperm survival in the epididymis, i.e. at least 10-12 weeks. In fact this animal had no active sperm in the epididymis either (D. Spencer pers. comm.) and even assuming occasional males could retain active sperm, this is anyway stretching known sperm survival time to its limits (V. W. Holt pers. comm.) though it is more likely than a second burst of spermatogenesis. The latter would have to be activated in March for conception to occur in May and this was clearly not the case in this specimen. The most likely explanation is therefore spermatogenesis occurring in pubertal males along with the associated behaviour changes. The Paneery boar was in fact recorded as being sub-adult at that time, although the age of the sow is not known. Moreover, the second out of season pregnancy that was recorded at Zurich in 1978 was definitely resultant from a pubertal conception from a sub-adult pair born on May 2nd 1977, and which had been isolated with their litter mates since the death of their own dam in August, 1977. Unfortunately this pregnancy was unsuccessful and this animal also died following a caesarian section. However, she must have conceived in late May or June to be full-term in mid September, i.e. at approximately 13 months of age. Persistant copulation attempts were also observed by the 11 month old male at Gauhati Zoo in mid-April, but these were always eventually thwarted by the young sow (litter mate) squatting on her hind quarters or even biting at the males flanks, and in this case a subsequent pregnancy was not recorded. Indeed it seems probable that sows do not normally reproduce until their second season; the earliest recorded (in season) primiparous birth being the $\frac{1}{2}F^2$ litter born in Gauhati on 14th May 1976 i.e. a backcross from the female born on 14th May 1974.

Out of season conceptions are certainly unusual, though there have been incidental observations of attempted matings at various times

of the year when boars and sows are kept together such as those already mentioned which were associated with presumed pubescence. Such attempts may include penile erection and even intromission and thrusting, but are generally terminated by the (anoestrus) female moving away before this stage is reached. J. G. Oliver (pers. comm.) has described how he has twice seen the introduction of a new female to an adult boar in which the female lay down quite still and was sniffed all over by the male before the latter lost interest and walked away. In these instances however, there may well be submissive overtones in the encounter as on another occasion a young sow was killed by a boar after being introduced to his enclosure.

Generally speaking however the adult male to female relationship is peaceful if somewhat disinterested outside the rutting season. The duration of rut has not been precisely defined but undoubtedly starts towards the end of December and continues until early or mid-February. Unfortunately there is still no clear information on the gestation period of pigmy hog though it probably approximates that of 112-115 days for wild boar though it may be somewhat less than this. The earliest recorded mating occurred on 22nd December 1972 at Paneery Tea Estate and may have resulted in one of the two births recorded on 24th and 30th April 1973, i.e. a gestation of $\lesssim$121 days. By contrast, whilst no precise matings have been recorded at Gauhati Zoo, the zoo authorities testify to all matings having occurred early in February which gives a maximum gestation of only $\lesssim$100 days for all of their births. Oestrus is apparently indicated by associated behavioural changes including restlessness, disinterest in food and irritation towards conspecifics. Sows are probably not capable of reproducing until their second season, the youngest recorded primiparous birth is the $\frac{1}{2}F^2$ litter born at Gauhati Zoo on 14th May 1976, i.e. a backcross from the female born 14th May 1974.

There is a very clear correlation between the ensuing brief breeding season in late April—mid May and various seasonal bioclimatic changes which will favour reproduction. This is undoubtedly the most suitable period environmentally for parturitions to take place as it coincides with the regrowth of vegetation consequent of early rains towards the end of the dry season in late March and April. Infants will thus be well developed before the heaviest sustained monsoon rains in June, July and August when conditions are less favourable, see Fig. 2.

Litter size varies from 3 to 6 with an average litter of 4 from 11 litters born since 1971. The singleton litters supposedly born at London Zoo on 16th May 1884 and 23rd June 1886 appear to be atypical but are probably not realistic as only known live infants were recorded at that time. Thus a post-mortem examination undertaken on a pregnant sow "that had been recently acquired by the society" contained five foetuses (Garson 1883), though unfortunately there is no record of date of death and estimation of foetal age. There has been only one litter of 6 and this is presumably the maximum number in view of *S. salvanius* possessing only 3 pairs of mammae (in contrast to the 6 pairs typical of other *Sus* sp.) The incidence of runts seems quite high in captive animals having occurred in at least three of these 11 litters, but does not seem to be clearly related to litter size, i.e. runts have occurred in litters of 3 and 4 piglets as well as the litter of 6.

Pre-parturition nestbuilding typical of the other larger *Sus* sp. occurs also in pigmy hogs, though as nests are built at all times of the

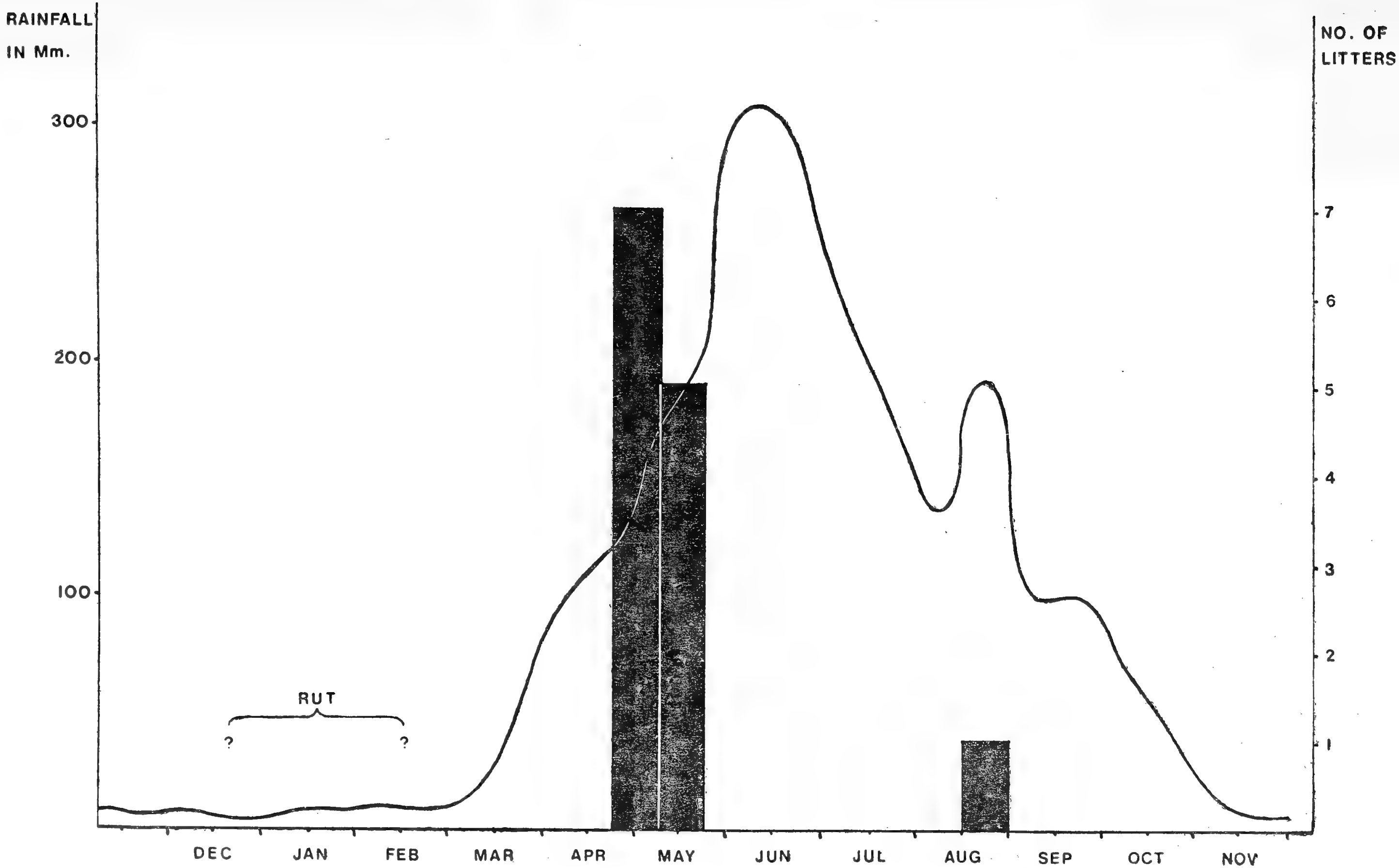


Fig. 2. Average rainfall in the Barnadi area of NW. Assam for the 16 year period from 1960 to 1976, plotted against the frequency distribution of 13 litters of *Sus salvanius* from Barnadi stock that have been born in captivity since 1971.
Rainfall records based on fortnightly totals kindly supplied by the Attareekhat Tea Company.

year in this species (see next section) there is a new, but not a special nest built for farrowing. Maternal behaviour is apparently typical of other species in most respects. Infants are believed to suckle within the first few hours of birth and sows normally lie down to nurse, though they have been observed nursing in a standing position (Gohain-Burau pers. comm.) Post-natal sows remain with their litters and only emerge occasionally for short periods to find food. Piglets do not emerge from the nest until the fifth or sixth day and then only for brief periods at first, staying very close and behind their dams. A. Wrangham (in litt.) has described some neonate piglets hand-reared by her from a litter of 3♂♂ 3♀♀ born at Paneery Tea Estate on 24th April 1973. "At three days the piglets had their eyes fully open, a full set of milk teeth and an approximated average weight of 50 gms. The pelage which at first was downy and sparse and of a uniform pale grey-brown in colour, later developed very definite tan stripes running horizontally from neck to rump. These stripes developed at approximately four weeks of age and remained visible for a few weeks when their pelage became a darker grey and very coarse. Play behaviour became quite pronounced and included jousting nose to nose, running in bursts and then standing stock still, rooting in the ground and collecting straw in their mouths and placing it on the nest. One of the female piglets was a runt which died at three or four days old. It was undersized and weak and did not have its eyes open". The rest of the litter was hand-reared, (for details see Mallinson, 1977) following the death of the dam from heat exhaustion leading to heart failure during attempts to recapture her following her escape from her enclosure two days after parturition.

One of the remaining two handreared females died at 19 weeks, possibly from a snakebite, but the other was successfully reared and subsequently gave birth to her first litter of three on 18th May 1976. This sow was later exported in November 1976 to Zurich Zoo where she gave birth to a second litter of 4/1 on 2nd May 1977. This was the first complete litter ever to be reared successfully. The sow became noticeably pregnant 66 days before parturition and her mammaries became noticeably swollen at 31 days pre-parturition. There is an interesting disparity between the very small size of neonate piglets previously recorded at Paneery to those at Zurich which weighed between 150 gm and 257 gm at four days (Schmidt *et al.* 1978). These were also described as having a greyish-pink colour, though longitudinal striping developed at only 11 days, at which time they were also observed eating solids (banana) for the first time. At 109 days of age their weight had increased to between 1700 gm and 1930 gm.

Infant mortality is undoubtedly high in wild populations, with inclement weather, predators and parasite-born disease all taking their toll just as in other species, e.g. as estimated 65% of juvenile wild boar are lost in the first seven months (B. Grzimek op. cit.). The very small size of neonate piglets must put them particularly at risk from severe weather conditions, such as early monsoon rains and from a wide variety of small predators including mongoose and leopard cat (both observed in pigmy hog habitat), raptors and crows, etc. Indian mongoose *Herpestes edwardsii* and crows *Corvus splendens* have both taken neonate piglets from Gauhati Zoo (Gohain-Barau pers. comm.). However the extremely high rate of infant mortality amongst captive stocks that is evident from Table 1, cannot be justified in these terms. Certainly a small percentage of post-partum deaths can

TABLE 2

NATURE AND DIMENSIONS OF NESTS MADE BY PIGMY HOG *S. salvanius* IN THE WILD AND IN CAPTIVITY

	No.	Overall dimension (cm.) length	Overall dimension (cm.) width	Overall dimension (cm.) height*	Wt. of accumulated vegetation (Kg.)	length	Dimension of central depression (cm.) height	Dimension of central depression (cm.) depth**	Comment
Wild	1	122	76	20	11	61	61	10	Nest in use. Location by discarded harness. Almost exclusively made up of thatch with few leaves and some soil. Clearly discernable entrance/exit hole. Engorged ticks found in nest.
	2	112	61	20	10.5	69	36	9	Nest very fresh, probably in use. Central chamber 40 cm. × 40 cm. in diam. with entrance/ exit hole. Almost exclusively made up of thatch, few leaves and herbaceous plants, soil. Engorged ticks found in nest.
	3	91	76	22	10.0	61	51	10	Old nest in almost pure thatch area. Nest purely thatch and soil.
	4	137	79	18	17	61	43	9	Old nest, largest found, though weight unreliable as wet.
	5	92	90	14	16	71	61	11	Old nest, mostly thatch, some herbaceous plants.
Captivity	1	119	76	20	16	61	51	13	Composed of grasses, not thatch though some thatch available in paddock. Built by single male. large quantity of soil.
	2	117	84	13	17	56	42	9	Composed of grasses only, all cut within a clear swathe within—2 m. of nest perimeter. Repeated nest building after being destroyed. Built by single male.
	3	124	69	19	12	69	46	20	Nest composed only of grasses and built on slope, ground levelled beneath nest to form a flat step on which nest constructed. Built by single male.
Average		±114	±76	±18	±13.7	±64	±49	±10	

* above ground level ** below ground level

be reasonably expected under any circumstances, and even in domestic swine approximately 6% of piglets die within a few hours of birth (Signoret *et al.* 1962), though this in no way explains the high percentage loss in the captive breeding of pigmy hogs. The large number of neonate piglets eaten or neglected by their dams, for example, is only partly consequent of the acquisition of late-term pregnant animals from the wild as several litters have been lost from conceptions in captivity. There is no doubt that the main criteria has been stress and this has included failure to separate expectant sows from other animals, human disturbance by the over-zealous inspection of new litters, failure to provide sufficient cover or even poorly designed accommodation (leading to stress from the outside of enclosures or even the predation of neonate piglets evident at Gauhati Zoo). Only approximately a third of the pigmy hogs born in captivity have been reared to independence and only a very few of these have reached breeding age. This cannot be argued away (as has been attempted) as poor inate maternal care, but must instead reflect the generally poor standards of husbandry that have marred the efforts to establish these animals viably as captive populations.

Nest building

Whilst nest building is widespread and probably common to all the Old World pigs, including wild boars *Sus* sp., bush pigs *Potamochoerus africanus* and even babirusa *Babyrousa babyrussa* (G. Musser, pers. comm.), nests are generally built only by late-term sows as a prelude to farrowing for the protection of neonate infants. The non-seasonal nestbuilding behaviour of pigmy hogs is therefore unusual and possibly unique among suids. Captive hogs certainly build nests and use nests at all times of the year and the remains of some very old nests found in Barnadi Reserve Forest in mid-April indicates that this activity also occurs in the wild, i.e. the nests were too old to be associated with parturition. Moreover, nests are made by boars and sub-adults as well as sows in captivity, and the retrieval of the discarded radio-harness from a fresh nest in Barnadi demonstrates the active use of a nest by that male (see Plate I).

The nature and dimensions of these nests are listed in Table 2 which is based on several nests found in the wild and some of those made by the Pertabgur boars. These are remarkably consistent except for minor variations in size and shape and are similar to the farrowing nests made by wild boars and domestic swine. Nests are constructed by first digging an oval or circular depression in the ground by rooting and pushing soil outwards with their snouts. The accumulated soil thus forms a rim around the central concavity which has a approximated average depth of ten centimetres below ground level (see Fig. 3). This is padded with broken thatch or other plant material collected by biting it off at the roots or pulling it out of the ground. All material is gathered in the immediate vicinity of the nest and one of the Pertabgur boars cut a very obvious swathe through long grass within a two metre perimeter of his nest site in this way. Nesting material is carried in the mouth and some of it is shredded by chaffing it with their teeth. Dead leaves and other plant debris is also added, and by rooting and jerking with their snouts around the nest perimeter onsiderable quantities of soil are thrown over the mound of vegetation. A nest chamber is shaped from within by treading, turning and chaffing the vegetation. Undisturbed

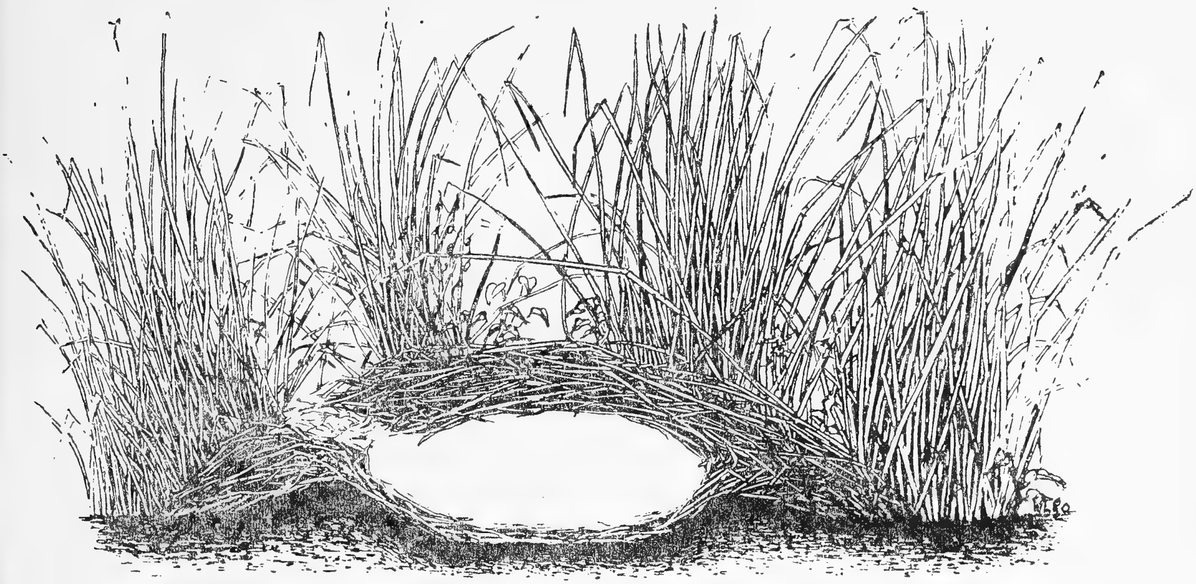


Fig. 3. Schematic section of a typical wild pigmy hog nest.

nests have a discernable entrance/exit hole usually at one end of the long diameter of the generally oval-shaped nest mound.

These nests are seemingly effective constructions as the two fresh nests found were quite dry inside despite moderately heavy rain the previous night. They are always situated in very dense vegetation and being primarily constructed of thatch grasses, are well concealed and very difficult to find. It seems likely that nests are used for some time as even careful screening reveals only a few nests over a wide area despite the fact that old nests deteriorate slowly and will thus remain recognisable for a considerable time.

This is particularly true as there is evidence that more than one nest may be in use at the same time. The two fresh nests discovered at Barnadi were about 80 metres apart and the second nest site fell well within the monitored range of movements of the animal before the recovery of its harness at the first nest site. It is almost certain from the good condition of these nests and the engorged ticks found inside, that both were in current use though it is not known whether they were used as alternative sites for one group/individual or by different groups/individuals.

The maintenance and use of two or more alternative nests is certainly known in captive animals. Several new and old nests were found within the thick vegetation of the enclosures at Pertabgur, though nest building activity varied to some extent amongst the three individual boars. Two of them tended to favour an artificial hay nest beneath a small shelter that had been provided in each pen, whilst the third generally used nests he had made himself. Moreover, we alternated between two different nests, both of which were used for several days in succession. The removal of the artificial nests and the demoli-

tion of their own nests led to the construction of new nests by all three boars the same evening. One of these boars built a new nest in exactly the same location on three successive nights after the removal of his new nest on each of these afternoons.

Nests are retired to during inactivity phases during the night and the hottest part of the day and also to seek cover when disturbed in captivity. New nest construction or addition and repair to existing nests, invariably occurs towards dusk and may be undertaken by single individuals, e.g. the Pertabgur boars; or co-operatively e.g. the young pair (whose nest activity was intermittent) and the two adult sows (but not the adult boar during our observation) at Gauhati Zoo. Social units obviously share a communal nest (or nests) and contact behaviour is very pronounced in this situation with hogs lying piled together within the nest chamber. Defaecation or urination apparently never occurs within the nest.

Activity rhythms

Pigmy hogs must be regarded as essentially diurnal, though in fact activity may begin shortly before dawn and generally continues well after dusk. There is an expected correlation in activity levels with weather and ambient temperatures, with a tendency towards inactivity during the hottest part of the day or in heavy rain. Contrarily, they may remain more or less continuously active during mild weather.

During a single day's observation at Gauhati Zoo, the young pair of animals became active approximately ninety minutes after dawn and remained active until seventy five minutes after dusk. There was only intermittent spells of inactivity during the whole of this (± fourteen hour) period and these were of short duration and roughly equated with increased drizzle on a generally overcast day. There was complete cessation of activity on the previous day's observation during spells of heavier rain, but activity continued in the absence of rain later in the afternoon, until approximately two and a half hours after dusk.

The absence of cover in the Gauhati Zoo enclosure is clearly important in the evident weather-bias in activity and the exceptionally heavy cover that prevails in the wild situation undoubtedly affords a good measure of protection from rain. Indeed it is the nature and density of this habitat that explains their otherwise rather surprising diurnal behaviour.

No attempt has been made to quantify the activity readings from the radio-marked animals as these are relatively few in number owing to small localised movements being indistinguishable from the subjective errors in taking directional bearings. Considering only large scale movements therefore, i.e. those essentially associated with foraging, these broadly confirm the expected early morning, afternoon and evening activity. The earliest recorded definitely detectable movements occurred about twenty minutes after dawn and continued for up to about four hours, when activity tended to tail off with the increase in ambient temperature (± 33°C). Similarly activity again became apparent about three hours before dusk and continued intermittently until up to two or three hours after dusk. The latest recorded activity on any occasion occurred at 21.15 i.e. ± two and three-quarter hours after dusk, though it is possible that there are seasonal changes in nocturnal activity. In the absence of sweat glands, pigs must rely on behavioural thermoregulation and Kurz & Marchinton (1972) noted an increase in nocturnal activity and corresponding de-

crease in diurnal activity in feral hogs during summer months. Wallowing, which is commonly associated with thermoregulation in pigs, has never been recorded for pigmy hogs and behaviour resultant of increases in ambient temperature seems to be restricted to inactivity by resting in the shade or in the nest though they do in fact seem to lose some sweat from orbital glands.

Food and feeding behaviour

Searching for food is naturally the primary occupation of pigmy hog activity and in both food preference and feeding behaviour they again seem to be quite typical of the other larger species. Foraging essentially consists of active searching with intermittent pauses to root in the ground with their snouts to dig and turn over litter and top soil, thereby leaving the small but distinctive forage marks that denote recent pigmy hog activity. When rooting they adopt a familiar rooting stance of standing with legs braced to push soil over either forwards or to the side. Rooting may be specifically directed at searching for favoured foodstuffs, or be purely randomised i.e. opportunistic rooting. If rooting is profitable, the food is consumed in situ and excavation continues; or if not profitable, they root briefly in two or three other places in the immediate vicinity before walkng some distance and repeating the performance. They are habitual foragers spending in the region of six to eight hours a day actively searching for food. This is also true for captive animals, (even in an ad-lib feeding situation) but only if foraging can be profitable. Thus despite the very large quantities of food that were always given to the animals at Gauhati Zoo because of food stealing by wild monkeys *Macaca*, the young pair of hogs spent up to ten hours a day foraging in their enclosure.

The overall movements of an individual or group often seem to be quite random whilst foraging, though the group itself maintains cohesion by keeping vocal contact (soft grunting) with each other. Most foraging is within the thatch-scrub itself, particularly in small clearings, elephant tracks or other places where the tall scrub gives way to mixed ground vegetation where foraging is more profitable. There is no evidence that they travel long distances to find forage, but they frequently forage in light cover peripheral to their habitation areas, though even this seemed to occur only at first light or more frequently under the cover of darkness. It is very doubtful that they ever voluntarily move far from cover or travel across open ground, though they will visit adjacent paddy fields. Pigmy hogs from a population that formerly occurred in Khalingduar Reserve Forest were observed in the bordering Nonaipara and Majuli Tea Estates which they could reach without leaving cover. In November, 1969 hogs were observed foraging for tubers of the herb *Oxalis acetosella* in Nonaipara (J. Gilchrist, pers. comm.) and this is one of the very few reliable reports of pigmy hogs on tea estates that have occurred at a time of the year that cannot be associated with population displacement by dry season burning.

Being highly omnivorous, pigmy hogs consume a very wide range of foodstuffs including roots and tubers, grass, leaves, shoots, fruits and seeds, insects, earthworms and other small animals and probably even nestling birds, eggs and carrion. The hogs at Gauhati Zoo have been known to readily consume dead birds and take meat from goat ribs in addition to a large variety of cereals, vegetables and seasonal fruits.

Whilst foraging, pigmy hogs naturally consume large quantities of earth. This is shown

in Table 3 where the inorganic constituents (ash) from stomach content analysis is basically soil and represents approximately fifty per cent of ingested material (dry weight).

TABLE 3

SUMMARY OF NUTRIENT ANALYSIS OF THE STOMACH CONTENT OF A DRIED SAMPLE TAKEN FROM A WILD MALE PIGMY HOG *Sus salvanius*, AND A COMPARATIVE ANALYSIS OF COMMERCIAL OMNIVOROUS PELLET DIET SUITABLE FOR WILD PIGS

	Pigmy Hog stomach contents	Zoo Diet A (BP Nutrition) for wild pigs etc.
% of Dry Matter	93.9	90 approx.
% of Dry Matter as:		
Crude Protein	8.7	26.0
Crude Fat	3.3	7.8
Ash	50.3	7.0
Total carbohydrate	37.7	50.0
Gross energy	1871 Kcals/Kg	3660 Kcals/Kg

(N.B. Apart from the surprising low crude protein content, the nutrient breakdown is very similar considering the 50% inorganic content of the stomach sample).

The gross examination of this sample (which originated from the male killed in Barnadi in April) revealed that was comprised predominately of soil particles, fibrous plant material and insect exoskeletal material (chiefly ant-heads). Gross examination of faeces removed from the rectum of this specimen also showed a predominance of soil particles and exoskeletal matter so it is likely that the remarkably high level of inorganic material does actually represent the dry weight percentage ingested, rather than a simple retention of soil particles within the stomach. The rather low crude protein component shown may actually overestimate the digestable protein content considering the high level of indigestable exoskeletal material, which should be classified with the 'fibre' category (G. King, pers. comm.).

The amount of free water taken by pigmy hogs probably varies considerably throughout the year and it is likely that they can survive for long periods during the dry season by subsisting on dew and the water content of their diet. Regular visits to two water holes in Barnadi during dry weather never revealed traces of pigmy hog activity and the animals would anyway have to travel considerable distances over open ground to reach these. Animals seeking refuge in Budlapara Tea Estate having been displaced by dry season burning in Barnadi, do however visit settling tanks to drink (D. J. Mukherjee, pers. comm.) though this may, in part, reflect the poor quality of forage available to the hogs in these circumstances.

PARASITOLOGY

Pigmy hog are host to a number of ectoparasites, examples of which were collected from nests, living and dead animals and dried skins. These include species of flea (Siphonaptera), louse (Phthiraptera) and two species of tick (Acarina), all of which were subsequently identified by the Commonwealth Institute of Entomology and the Acarology Section, Zoological Survey of India. Of these only the fleas *Ctenocephalides* sp. (family Pulicidae) are probably of no great interest as they were found on only two of the captive hogs at Pertabgur. The genus is not host specific and these almost certainly represent merely a small local infection from contact with domestic livestock or house pets.

In contrast, the lice being permanent obligatory parasites, are very likely to be host specific and specimens were found on all animals examined (they evidently do not leave

host's body after death and were also found on preserved skins of deceased hogs previously maintained on Paneery and Attareekhat Tea Estates). They have been identified as belonging to the genus of sucking lice *Haematopinus* (Haematopinidae) though the species is new to science and has now been described as a *H. oliveri* (Mishra and Singh, 1978). Infestation was always moderately heavy and well over a dozen adult specimens were removed from some animals. They are an active species that may be found almost anywhere on the host, but especially on the neck, shoulders, axillae and groin. Some *Haemotopinus* sp. are well known parasites of domestic mammals and the largest species of the genus *H. suis* is the only louse known to infest domestic swine, G. Lapage (1956).

The spread of lice and the evident ubiquity of infestation of this species in particular, is clearly facilitated by the social nesting and contact behaviour of wild pigs. Nest building may also facilitate the spread of the tick parasitism and both species of tick (Ixodidae) were recovered from within the fresh nests in Barnadi. These comprised four female (all engorged) *Dermacentor* sp. (two from each nest) and seven male *Rhipicephalus haemaphysaloides* (Supino). Only one of the latter was recovered from a nest, the remainder being taken from the skin of wild caught animals. Most records of *Dermacentor* from India are of *D. auratus* though those specimens collected show some variation from *auratus* in respect of scutal shape and coxal spurs (S. K. Gupta pers. comm.). *D. auratus* is probably a complex of species and the specimens have been referred to as "*D. auratus* Supino group" or "*D. auratus* Supino sensu Aurthur, 1960" (D. Macfarlane pers. comm.). Probably neither species however is (adult) host specific.

Little is known about endoparasites of pigmy hogs and no serious infestation has been recorded. Some roundworms (unspecified) were taken from the colon of a wild caught female in 1972, and all captive animals on tea estates at that time were then treated with Helmacid citrate, but no ova or cysts have since been recorded from occasional faecal testing. Round worms and tapeworms have been found in Gauhati Zoo stock and these animals are now routinely dosed for worms once a month. Faecal samples from the dead animals in Barnadi and from Gauhati and Pertabgur in 1977, all proved negative for parasitic ova and cysts (G. King, pers. comm.).

NOTE ON THE HISPID HARE

In contrast to the pigmy hog, very little new information about the hispid hare has materialised in recent years apart from the brief published descriptions by Mallinson (1971) and Tessier-Yandell (1972). Both these accounts relate to the acquisition of a single male specimen from Barnadi Reserve Forest on 22nd April 1971 by Warendra Singh, then Manager of Attareekhat Tea Estate. This animal lived for only about three months and there were no further records until late March 1976, when a female was acquired by Singh from the same source. This second animal also survival for only a short time, though three days after capture it gave birth to a single infant which also died after a few days. Unfortunately almost no information has been recorded about this infant or even its date of birth, though this presumably occurred at the end of March or beginning of April. Several other hispid hare has been caught for the Gauhati Zoo in the Manas Sanctuary during the dry seasons of 1976 and 1977 (Gohain-Barau pers. comm.). None of these animals have reached their destination however, all

having succumbed within a few days of capture.

These deaths are undoubtedly attributable to stress and physical damage from collision with cage fixtures resultant of their extreme timidity and flight reaction. The original male acquired by Singh eventually died from a fractured skull and "would try very desperately to avoid any human interference and as soon as it heard any kind of noise, would run madly in its enclosure and dash against the wire fencing causing bleeding from the nose" (Singh in litt.). Such a disposition probably coupled with a disease-susceptibility typical of hares, renders any further attempts at captive husbandry of doubtful merit without considerable expertise and experience of comparable species.

Unfortunately this also precludes captive research which would otherwise reveal much about the biology of this species, just as it has with the pigmy hog. There are certainly fewer reports of them in the wild than there are of pigmy hog and this fact, together with a common failure by many local people to distinguish between *Caprolagus* and the much more common and widely distributed Indian hare *Lepus nigricollis*, is reflected in a paucity of general information about the species. *Lepus* was certainly very common and frequently observed in Barnadi, though *Caprolagus* was only seen on two occasions; once briefly when a specimen was flushed by a dog and dashed across a jeep track, and secondly when a female was accidentally caught whilst driving for pigmy hog for harness attachment, see Plate II. She was released after being photographed and briefly examined, though this release was only achieved after a great deal of argument with the beaters who wanted to butcher her for later consumption. It is worth noting, in this context, that, even though these particular people readily distinguished between the two sorts of 'rabbit' and even had separate names for them, they entirely failed to appreciate their differing status or the reasons for it. This is in marked contrast to pigmy hog which is known to be protected and though it is still eaten, it is never hunted openly.

The capture of this animal occurred on 19th April 1977 at a time when she was heavily pregnant, at most only a few days pre-parturition on the basis of her swollen mammaries. This date and the parturition in Attareekhat indicate a birth peak at this time, though there may well be two litters born annually. A forest guard and a mahout at Manas Sanctuary both stated that they had seen infants on a number of occasions, usually in late June or July, but occasionally in April. Births are said to take place in clumps of thatch in heavy cover and litter size varied from two to five infants.

There is no evidence for burrowing or nest building behaviour in this species. The original male at Attareekhat made no attempt to burrow in the soil floor of its enclosure and no burrows or nests were found in Barnadi. The only physical evidence for hispid hare activity is therefore the characteristic thatch-cuttings and faecal deposits that denote resting and feeding places, but may also have territorial significance by acting as demarcation sites (see Plate II).

Several of these sites were invariably found in close proximity to one another, though a group of individual sites is usually widely separated from another group of sites. Sites always contained both thatch-cuttings, comprising the outer sheaths (< 10 cm in length) of shoots that had been consumed in situ, and faeces. The faeces are the typical ellipsoidal droppings of lagomorphs, but are of two dis-

tinct sizes, i.e. approximately 1.0 cm and 1.5 cm diameter. Generally speaking a collection of sites comprised droppings of only one size (indicating site use by a single animal) but occasionally a collection site comprised droppings of two sizes (indicating use by a pair). Individual sites within a particular site collection always contained faecal material of only one size however. As these observations were made towards the end of April it is not clear whether size disparity of faeces is related to sex or mother and young. The species is certainly asocial, and most records refer to a single animal, though there have been occasional report of pairs associating together.

From variance in the relative decomposition of faecal matter in different sites within a particular area, it is apparent that the animals retire to feed at slightly different sites within a preferred locale, though the accumulation of thatch-cuttings and faeces would indicate that a particular site is used for some time. Apart from thatch shoots, which are bitten off at the base, it is probably that the species also feeds extensively on roots and Singh has reported that the male maintained by him would eat only soaked gram and the roots of 'dub' (or 'dhoob') grass *Cynodon dactylon* and not the grass itself. *Caprolagus* undoubtedly feeds primarily within the thatch-scrub though it is reputed to forage occasionally in adjoining paddy areas. However this was not confirmed by regular screening with a torch at night, though *Lepus* was commonly observed to emerge from scrub to forage in these circumstances. It is unlikely that there is much competition between the two species except possibly in the dry season, but their ecological relationship in areas such as Barnadi where they are sympatric, would be well worth further investigation.

Summary

(1) This paper represents the second part of a general report based on a field survey of pigmy hog *Sus salvanius* and hispid hare *Caprolagus hispidus* that was undertaken in north-western Assam in the period late March to mid June 1977. The first part, which has been printed separately, deals with the conservation of these animals and, though the two aspects of conservation and biology are closely interrelated, efforts have been made to reiterate information presented as little as possible. The survey was sponsored by the Assam Valley Wildlife Society and the Wildlife Preservation Trust, and had the full cooperation of the Assam Forest Department.

(2) Opportunities for field study are somewhat limited as ethological observation is essentially precluded by their small size, secretive habits and their dense and observationally unsuitable habitat. Methods of study have therefore relied heavily on physical evidence of their activity in the field, the radio-tracking of two wild male pigmy hogs and observations of captive animals at the Assam State Zoo, Gauhati, and at Pertabgur Tea Estate, Darrang. Data obtained in this way has been pooled with various eye-witness accounts, captive stock records and correspondence files, in order to formulate generalisations about their biology.

(3) The former and present distribution of these species has been considered at some length in the earlier report, but can be exclusively equated with the

dense thatch-scrub jungle that typically occurs along the southern edge of the Himalayan foothills. This upland savannah is essentially flat, well-drained and thinly forested, but natural habitat is now in very short supply owing to progressive human settlement and encroachment, and the ecological distortion brought about by the almost universal practise of dry-season burning. This has progressively reduced their former extensive distribution to a few remaining isolated populations whose size is directly proportional to the amount of habitat left unburnt. A tentative estimated density of one pigmy hog/5.34 hectares has been derived at from radio-tracking and random sampling of numbers disturbed in a given area.

(4) Their social behaviour appears to be generally similar to other *Sus* sp. with the size of social units being governed by a pattern of reproductive-based changes in sociality. The basic unit of a female/females with young of the previous season is socially cohesive and probably asocial to other family groups. Adult males are essentially solitary except during rut in late December to mid February when they temporarily join oestrus females and become highly intolerant of other males and undoubtedly cause some disruption to existing sounders by ousting sub-adult males. The latter may rejoin sows after rut, but the size of sounders is probably kept small by sows separating off to farrow.

(5) There is a well defined birth peak in late April to mid May which correlates with bio-climatic changes that favour reproduction. Litter size varies from 3 to 6 with a litter average of 4 (n = 11) from records of captive births since 1971. Nearly all information on reproduction is based on captive stocks, though the high incidence of breeding in captivity has failed to realise its potential owing to generally poor standards of husbandry leading to an unjustifiably high infant mortality.

(6) Nestbuilding behaviour is well developed and nests are constructed individually or co-operatively by all individuals at all times of the year. This is in marked contrast to other suids where nests are usually associated only with parturition, being built by late-term sows as a prelude to farrowing for the protection of neonate infants. Nests are similiar in construction to the farrowing nests of other *Sus* sp. and may be used for some time, though a particular individual or group may have more than one nest site in use.

(7) Pigmy hogs are essentially diurnal, though there is a tendency towards crepuscular behaviour with activity levels being influenced by weather and ambient temperatures. Most activity therefore occurs in the period from dawn to mid-morning and from mid-afternoon to two or three hours after dusk and the least activity in heavy rain or temperatures ± 33°C. Nest building generally occurs towards dusk and contact behaviour and social grooming is pronounced in inactivity phases.

(8) Foraging is naturally the primary occupation of pigmy hog activity and rooting may be specifically directed at searching for favoured foodstuffs such

as roots, tubers or small animal matter, or it may be randomised and opportunistic. The overall movements of a group appear to be randomised whilst foraging within the normal home range and they probably never travel long distances or far from cover to find food or water. Group cohesion is maintained in dense vegetation by vocalisation (soft grunting). They are highly omnivorous and a very wide variety of foodstuffs are consumed along with a surprisingly large quantity of soil (50% dry weight or ingested material).

(9) Pigmy hog are host to a number of ectoparasites including lice and ticks, though some fleas *Ctenocephalides* sp. from captive animals probably represent merely a small local infection. Two species of tick *Dermacentor* sp. and *Rhipicephalus* sp. were collected, mainly from fresh nests, and one species of louse *Haematopinus* was found on all animals examined, including preserved skins. This louse is probably host specific and is new to science and has been named as *H. oliveri*. Little is still known about endoparasitology though round worm and tape-worms have been recorded from captive animals.

(10) A note is included on the hispid hare *Caprolagus hispidus* though observations on this species were essentially incidental to the main study. Hispid hare remain generally poorly known and even most local people do not readily distinguish between this species which is restricted to thatch-scrub areas, and the much commoner and widely distributed Indian hare *Lepus nigricollis* which is sympatric with *Caprolagus* in areas such as Barnadi Reserve Forest. The few attempts to maintain hispid hare in captivity have been unsuccessful owing to their extreme nervous disposition and poor understanding of their biology. They are only rarely seen though they leave distinctive demarcation sites of thatch cuttings, on which they feed, and faeces, thereby signifying their habitation. They are asocial and usually solitary, though pairs have been reported on occasion. They probably have two litters annually during the wet season in April and late June/July.

References

Ewer, R. F. (1968): The Ethology of Mammals. Lagos Press Limited, London.

Garson, J. G. (1883): Notes on the Anatomy of *Sus salvanius* (*Porcula salvania,* Hodgson). Part 1. External characters and Visceral Anatomy. *Proc. Zoo Soc.* XXVIII: 413-418, Z.S.L.

Grzimek, B. (1972): Animal Life Encyclopedia, Vol. 13 (Mammals VI). Van Nostrand Reinhold Co., London and New York.

Hodgson, B. H. (1847): On a New Form of Hog Kind or Suidae. *J. Asiatic Soc. Bengal,* XVI: 423-428.

Kurz, J. C. & Marchinton, R. L. (1972): Radiotelemetry studies of feral hogs in South Carolina. Journal of Wildlife Management, Vol. 36, No. 4, pp. 1240-1248.

Lapage, G. (1956): Veterinary Parasitology. Oliver and Boyd, London. pp. 595-579.

Mallinson, J. J. C. (1971): The Pigmy Hog *Sus salvanius* (Hodgson) in Northern Assam. *J. Bombay nat. Hist. Soc. 68* (2): 424-433.

Mallinson, J. J. C. (1977): The Breeding of the Pigmy Hog *Sus salvanius* (Hodgson) in Northern Assam. ibid. *74* (2): 288-298.

Mishra, A. C. and Singh (1978): Description of *Haematopinus oliveri* sp. nov. parasitizing *Sus*

salvanius in India (Haematopinidae: Anoplura). *Bull. Zool. Survv. India,* 1(2): 107-109.

MOHR, E. (1960): Wilde Schweine. A. Ziesen Verlay, Hamburg, pp. 67-73.

OLIVER, W. L. R. (1978): The Doubtful Future of the Pigmy Hog and the Hispid Hare. *J. Bombay nat. Hist Soc. 75* (2): 341-372.

——————— Translocation as a Conservation Technique with special reference to the Pigmy Hog Project at the Orang Sanctuary; (manuscript in preparation).

RANJITSINH, M. K. (1972): A note on the future conservation plan for the Pygmy Hog (*Sus salvanius*) and Hispid Hare (*Caprolagus hispidus* Pearson 1939), D. O. No. 682/DSIF 1023/72 New Delhi, India.

SCHMIDT, C. R., MALLINSON, J. J. C. & WEILENMAN, P. (1978): International co-operation for captive breeding of the Pygmy Hog *Sus salvanius.* International Zoo News (in press).

SIGNORET, J. P., BALDWIN, B. A., ERASER, D. & HAFEZ, E. S. E. (1962): The Behaviour of Swine. The Behaviour of Domestic Animals, ed. by Hafez, E. S. E., Williams and Williams, Baltimore, Chapter 12, pp. 295-329.

TESSIER-YANDELL, J. (1971): The Pygmy Hog (*Sus salvanius*). *The Cheetal,* Vol. *14,* (3): 23-38. India.

——————— (1972): The Hispid Hare (*Caprolagus hispidus*). *The Cheetal, 15,* (1): 34-36. India.

REVIEWS

1. THE HERONS OF THE WORLD. By James Hancock and Hugh Elliott. pp. 304 (35×23 cm), with 61 paintings by Robert Gilmor and Pater Hayman. London, 1978. Editions Ltd.

This scholarly and definitive contribution to the natural history of the herons by two such eminent and widely travelled ornithologists is particularly timely and welcome. Timely because the increasing devastation of marshland habitats everywhere in the modern craze for industrialization and other forms of economic development has highlighted the urgent need for a closer study of heron ecology and life history in order to promote effective conservation strategies, especially in the case of the spatially restricted narrowly adapted forms. The very variable quality and quantity of existing information—a 'feast' in the case of about one-third the total species and 'famine' for the rest—made it the more necessary to familiarize ornithologists with the precise status of knowledge in each case and encourage them to fill the gaps. To achieve this the authors consulted close on a thousand references; the list of these covers ten closely printed 3-column pages at the end of the volume and forms an invaluable bibliography in itself.

The authors are needlessly apologetic for 'perhaps' devoting over-much space to topics like Distribution, Migration and Habitat. To the reviewer, and others like him, this indeed is one of the strong points of the book since so little is precisely known on these aspects except for a few comparatively common forms. The book describes and illustrates 61 species of 17 genera of herons (including egrets and bitterns) of which 18 are of special interest to us as occurring in the Indian subcontinent. The classification followed is the most recent one of Payne and Risley (1976) which is based on morphological, osteological and behavioural characters. In the process our long familiar *Egretta alba,* the Large White Egret, gets shunted to the genus *Ardea* and there are one or two other casualties of this sort.

The Foreword by Roger Tory Peterson pays tribute to the Bharatpur Waterbird Sanctuary rightly for its spectacular, perhaps unique assemblage of herons, egrets etc. but wrongly to 'a Maharaja's foresight to create an inviolate sanctuary'. To put the record straight it may be stated that the conversion of what was formerly the Maharaja's private duck-shooting preserve into this 'inviolate sanctuary' came only after the State was merged in the Indian Republic.

A variety of interesting topics of heron biology are discussed in the preliminary chapters, for example patterns, sequence and timing of moults in the context of Classification; general pattern of nuptial display in the family, and the function of nuptial plumes; feeding techniques of the various groups and individual forms, and so on. Migration patterns of the herons as so far known, are summarized. The dramatic range expansion of the Cattle Egret (*Bubulcus ibis*) east and west from its putative centre of radiation in Africa is traced.

The chapter on Conservation is particularly informative. With the shrinking wetland habitats of the heron tribe throughout the deve-

loping countries of the world due to drainage and reclamation and the widespread pollution of waters by industrial wastes and chemical pesticides, the herons are under heavy attack on all fronts, and in spite of their astonishing resiliency some species are becoming increasingly endangered. The enormity of the plumage trade, mostly affecting the white egrets which 'may have accounted for 200 million birds a year' during its 60 peak years between 1868 and 1922 had, by the turn of the century, driven several species to near extinction. With conservation measures initiated in 1889 by a group of Manchester ladies leading to the formation in England of the Royal Society for the Protection of Birds in 1904 and then to the combining of similar societies in Europe and U.S.A. into the International Committee (now Council) for Bird Preservation in 1922, a remarkable recovery in the status of the white egrets has come about.

The species descriptions that follow cover Distribution (with a map for each species at the end of the volume), Migration and Habitat, General appearance and identification, Behaviour (including feeding, breeding, and other facets of life history and habits), and in some cases also a useful note on taxonomy.

The explanation mooted for the two morphs of the Reef Heron—white and grey—namely differences in their respective feeding techniques, hunting success, safety from predation, etc. do not strike one as wholly convincing. At any rate according to Indian experience these differences between the white and dark morphs are not significant, though of course deeper study is needed to settle the point. Observers find difficulty in unequivocal distinction in the field between the white morph of the Reef Heron (*Egretta gularis*) and the Little Egret (*E. garzetta*), especially when the former is unaccompanied by one in the grey phase. Since in India the dark or melanistic morph of the Little Egret is unknown as in Africa, the possibility of confusion does not arise. It is pointed out that all subspecies of *E. gularis* can be recognized by the down-curved appearance of the longer, heavier and basally yellow bill *contra* straight, slender and almost black in the Little Egret. One of the very few reliable distinctions with a specimen in the hand (presumably) is given as the ratio of the tarsus length to the bill length which is about 14% greater in the Little Egret.

In regard to the sporadic Indian occurrences of the Goliath Heron (*Ardea goliath*) the authors tend to support Moreau's belief that there may exist, somewhere within our territory itself. breeding populations whence these examples originate since there is no evidence at all of migration from Africa, as has been presumed.

I have nothing but praise for this excellent publication. The plates are uniformly of the high standard one has come to expect from such accomplished bird illustrators as Robert Gilmor and Peter Hayman. It seems a pity, though, that no scale of size is indicated on the plates themselves so that in the case of unfamiliar exotic species the reader need not rummage in the text to find out. Another minor criticism could be the size and weight of the book which make it less convenient for use on a usually cluttered work desk. The large 'coffee-table' format admittedly enhances the attractiveness of the beautiful plates; all the same the publishers would perhaps consider bringing out a smaller and handier 'utility edition' for day-to-day use by working ornithologists?

SALIM ALI

2. A DICTIONARY OF LIFE SCIENCES. Edited by E. A. Martin. pp. 374 (12.5 × 19.5 cm). London, 1978. Pan Books Ltd. Price £1.50 in U.K.

In the last two-three decades there has been enormous addition to the literature in the life sciences. Character and content of books in various fields of biology display the integrated nature of life sciences, which naturally brought in new terminology in life sciences literature.

This handy dictionary provides easy reference, concise and precise descriptions, suitable illustrations, including a chart giving origin of metabolic systems and major groups of organisms. Being a dictionary there is no introduction or preface for the book though on the outside back cover, the contents, of the book is enumerated briefly.

The dictionary is not exhaustive nor exclusive, as a large number of words prefixed 'Bio' and suffixed 'biology' are not listed (Biomagnification, Biogas, Radiobiology, Spacebiology, Aerobiology etc.). Latest terminologies like Molecular cladogram, Thermography etc. are also missing.

However in general, the qualities of the book make it very useful and handy to students, teachers and to every interested layman. A useful addition to libraries and it should play an important role in College Education for many years.

A. K. JOSHEE

3. THE BIRDS OF CHINA, MONGOLIA AND KOREA: Vol. 1, Non-Passerines. (Les Oiseaux de Chine, de Mongolie et de Corée, *non passereaux*). By R. D. Etchécopar and (the late) François Hüe. pp. 586 (24 × 16 cm), with 22 coloured and 2 monochrome plates by Paul Barruel and Francis Berille. Two end-paper maps by Patrik Suire, Tahiti, 1978. Les editions du Pacifique. Price US $113.00.

'Then felt I like some watcher of the skies when a new planet swims into his ken', or rather a binary star in the ornithological sky. For some twenty years ago Messrs Etchécopar and Hüe began the study of the birds in the great arid, and largely uninhabited, area which lies south of the Palaearctic Region. BIRDS OF NORTH AFRICA, from the Canary Islands over the Sahara to Suez, appeared in 1964; BIRDS OF THE NEAR AND MIDDLE EAST, presumably covering Syria, Iraq, Iran and Afghanistan, was published in 1970, and the present volume covers the eastward extension of this area through the Gobi and Tibetan wastes but also includes the whole of China, Mongolia and Korea.[1] The project is to be completed with a fourth volume on the Passerines. That M. Etchécopar has accomplished so much is the more admirable because his friend and colleague, François Hüe, was killed in a motor-car accident in January 1972. As Charles Vaurie says in his Preface, it was so bold an undertaking that it seemed impossible. But although M. Etchécopar was unable to observe

[1] OISEAUX D'AFRIQUE DU NORD (Birds of North Africa) and OISEAUX DU PROCHE ET DU MOYEN ORIENT (Birds of the Near and Middle East) were published by Maison Boubée, Paris.

the birds of China in the field himself, he had seen many of them in neighbouring countries and could rely on much published material and museum specimens. Encouraged by Messrs Sálim Ali, Greenway, Orr, Ripley, de Schauensee, Webster, Dolgoushine and above all Vaurie, he soldiered on. Political and economic difficulties were overcome and we now have this first volume, rather fat but very serviceable, typeset, printed and bound in France but published in Tahiti. The text is in French, but there is an index of English names, there are many distribution maps and first-class illustrations both black-and-white and coloured, and the arrangement is such that even someone ignorant of the French language should get some sustenance.

Comparison with the INDIAN HANDBOOK is inevitable. The 564 pages of text in BIRDS OF CHINA cover the Families described in 1270 pages of HANDBOOK'S vols. 1-4. The pattern is similar. A description of the Family is followed by a summary of the genera and species in it (races are seldom distinguished) and a Key. Then follow specific descriptions. The scientific, French and English names are given, with references to Plates where appropriate. Paragraphs on Identification in the museum and in the field, Behaviour, Nesting, Distribution in China, and in the rest of the world, follow. BIRDS OF CHINA however reduces information about subspecies to four or five lines each, so that, for examples, genus *Anser* occupies 8 pages in each book, but BIRDS OF CHINA covers 11 species and subspecies against the HANDBOOK's 5; while genus *Megalaima* in 6 pages covers 14 species and subspecies against the HANDBOOK's 16 in 18 pages. BIRDS OF CHINA also makes more use of line drawings and maps.

There is no bibliography in this volume but one is promised in Vol. 2 on the Passeriforms. It will surely include the INDIAN HANDBOOKS, though Etchécopar & Hüe's books appeared too late to be utilized by Sálim Ali & Ripley, the only reference to Etchécopar in their bibliography being to a study of the birds of Iran written in collaboration with C. Erard and published in the *Memoirs of the Museum of Natural History,* Paris.

After the major handicap of himself being unable to move freely in China the author's greatest problem was how to deal with place-names and their spelling. Not only have there been many changes for political and administrative reasons—sometimes 4 or 5 in the last century—but also French, English, German, Russian and Japanese spellings of the same name differ in roman transliteration, and are in cyrillic or Japanese characters in Russian and Japanese atlases. In this connexion M. Etchécopar quotes T. E. Lawrence's light-hearted remarks to the proof-reader of THE SEVEN PILLARS OF WISDOM: 'There are some systems of "scientific transliteration", helpful to people who know enough Arabic not to need helping, but a wash-out for the world. I spell my names anyhow, to show what rot the systems are.' Etchécopar is more consistent but allows himself plenty of discretion. He spells Pekin rather than Pai-Ping, North Vietnam for Tonkin and has compiled a useful four-page glossary, with references to the two political and physical end-paper maps.

The area covered in BIRDS OF CHINA is about three times as extensive as the Indian subcontinent, extending from 20° to 50°N.—Hong Kong is just south of the Tropic of Cancer—and from longitude 80° to 135°E. To quote Delacour's Preface: 'A vast desertic zone of more than 4000 km stretches in the north from Turkestan to Manchuria, and the country unrolls down the coast from north to south for an even greater distance before

meeting the Indochinese [*sic.* Vietnamese] frontier. The maritime and interior regions are very varied, passing gradually from a cold, very continental, climate to tropical monsoon conditions. Off the coast, which is everywhere rugged, are many islands, of which some such as Taiwan and Hainan are very large and contain a rich, fairly distinctive avifauna. The interior of the country is unique, with its many mountain chains, the highest and most impressive in the world, running from east to west and knotting together in the enormous Karakoram, the "roof of the world".

'Tibet, with its 2500 km breadth, at an average elevation of more than 5000 m, is also the largest plateau in the world. Some parts of it are still unexplored, particularly in the west, and together with the eastern and south-eastern mountainous regions, they are some of the richest evolutionary centres for the distribution of fauna and flora. This means that a work like this, by summarizing our knowledge, provides an indispensable base for further study. It is the more valuable because it is so well illustrated.'

Many species are common to India and China. Taking the Otididae as an example, the Great Bustard (*Otis tarda*), a rare winter vagrant in India, is both a resident and regular visitor to China; the Little Bustard (*O. tetrax*) a fairly regular winter visitor to Baluchistan and the NW. frontier, nests in Chinese Turkestan (incidentally Etchécoper does not recognize *O. t. orientalis* as a subspecies); and the Houbara (*Chlamydotis undulata*) breeds both in the Makran and Mongolia. But the Indian avifauna is richer here, and has three species which do not occur in China—*Choriotis nigriceps,* the Great Indian Bustard, *Eupodotis bengalensis,* the Bengal Florican, and *Sypheotides indica,* the Lesser Florican. In general, however, the Chinese avifauna seems somewhat richer than the Indian, 989 non-passerine species and subspecies being recorded by Etchécopar against the HANDBOOK's 884. The surprising thing is the very small number of birds which are recorded as regular visitors from China to India. The Wryneck (*Jynx torquilla chinensis*) comes to north-eastern India and Bangladesh from its breeding grounds in Chinese Turkestan; the European Bee-eater (*Merops apiaster*) is shown breeding near the Sino-Mongolian-Russian frontier and visiting Kashmir; and some Great Blackheaded Gulls (*Larus ichthyaetus*) may come from Mongolia. But it seems that most Chinese bipeds, feathered or not, remain inside the Middle Kingdom.

R. E. HAWKINS

4. JIM CORBETT'S INDIA, Stories selected by R. E. Hawkins. pp. 250 (24 × 15.5 cm). Bombay, 1978. Oxford University Press. Price Rs. 50/-.

Only a handful of the Society's members may have not read Jim Corbett's writings. THE MAN-EATERS OF KUMAON, MY INDIA, THE MAN-EATING LEOPARD OF RUDRAPRAYAG and others have made the jungles of the Kumaon and the denizens that lived within, come alive, to thousands of people throughout the world. (His books have been translated into 25 languages). And just as the man who experienced and told these tales was about to fade into the past, Oxford University Press has come out with a revival.

Jim Corbett's India is a judicious collection of short stories, hand-picked from Corbett's writing by R. E. Hawkins, a member of long-standing of the Society. A better selector would be hard to find. Hawkins, as he writes in his biographical introduction, received and published most of Corbett's books and through his correspondence came to know Corbett well, although he met him only twice, briefly.

In fact, the book is enhanced considerably by Hawkins' matter of fact but sensitive biographical sketch of Corbett. The frontispiece of a part of a large Victorian family, details of the bric-a-brac of Gurney House (Corbett's home) as it stands today, Corbett's dedicated career as a railway official, references from memoirs and letters are all meticulously used to evoke the nostalgia of the man you are about to read or re-read. It also includes some hitherto unknown facts about Jim Corbett. Who ever makes bequests to one's publisher? Hawkins' was privileged to receive a carpet and Corbett's 9 volume 2 column Shakespeare.

There was a time when the jungles of India abounded in wild-life. When life was more leisurely and people worked for their masters and not necessarily for their money. When the population was a sparse 200 million and when wild man-eating tigers and leopards spread terror in our villages. The stories in JIM CORBETT'S INDIA cover all this and much more.

It's all there once again, Jim Corbett—the story-teller par-excellence—sometimes bordering on the poetic, as when he writes about "the red ball in the sky fanned by a wind from an unseen furnace". He tells his story with a thrilling recollection of his real-life experiences, bringing the leopard of Rudraprayag right into our drawing rooms and taking us out into the jungles of the Kumaon, tracking a man-eater with the help of "bulbuls, drongoes, thrushes and scimitar babblers". To say that the published stories bear repetition is a gross-understatement. Even reading them for the second time evokes that one word that seems to tread lightly in the subconscious of the book—nostalgia. For those who may be reading Corbett for the first time and who do not belong to that generation that took pride in the dubious distinction of being hunters with a gun, you may overlook the initial references to wanton killing of wildlife. Hawkins has in the chronological selection of these stories, apart from fulfilling the objective of giving one an idea of the course of Jim Corbett's life, strikingly brought out his evolution from hunter to ardent conservationist. The collection facilitates frog-leaping. Each story is complete in itself and one loses nothing by skipping chapters.

And if for no other reason, the book is worth picking up for that simply marvellous unpublished piece on Goongi, the alleged 'wolf-child'. It's a lucid account of Corbett's detection work to get to the bottom of the mystery of Goongi and his logical deduction of her being a "bear-child'. I picked up the book for the sheer beauty of its dust-jacket.

DAVID FERNANDES

5. THE SIXTH SENSE OF ANIMALS. By Maurice Burton. pp. X + 182 (22 × 14 cm), with 16 Black-and-White photographs by Jane Burton, and 41 illustrations. London, 1973. J. M. Dent & Sons Ltd.

The seven wonders and the five senses have something in common: During the recent years man has made many things which could be added to the list of the wonders of the world. Yet it has not been done so. Similarly there are senses which are equally if not more effective than the commonly known five senses namely the senses of touch, taste, sight, smell and hearing. Whenever one of those less familiar senses happen to be dealt with it is provisionally treated as the 'sixth' sense. The conventional five senses are always taken as a constant and any other form of perception receives a mere temporary title, the 'sixth sense', just for the occasion.

The tendency to conform to the conventional in spite of the fresh knowledge acquired, is a trait of the conservative minded man and this has often been an impediment for progress in the field of science.

Maurice Burton, in his book on THE SIXTH SENSE OF ANIMALS has made a break through by bringing all these extra senses under one head and by explaining each item in a simple language.

While the book includes ready information for scientists and laymen alike, it is primarily meant for the common man with some basic inquisitiveness and interest to learn what is happening in the living world around him.

This being the purpose of writing this book, the author has treated these extra senses in different chapters, first dealing with one of the conventional senses and then describing one or more of those extra senses which may be related at least remotely to this particular sense. This is primarily to help the reader understand and assimilate the forthcoming information better.

The extra senses possessed by many animals are unique and varied. For instance, the electric sensory organ used by the African fresh water fish *Gymnarchus niloticus* enables it to distinguish between friend and foe, food and inedible objects, and even perceive the texture or inner components of an object from a distance. This fish in fact is using a sense that is wholly strange to us in which an electric field provides information by the distortion of its lines.

The rattle snakes and other pit vipers posses a pair of 'pits' between the eyes and the nostrils, and with these organs these snakes can 'see' an object in total darkness if it is warmer or colder than the surrounding temperature, even by 0.1°C. Each of these 'thermal eyes' in a rattle snake have five times as many heat receptors as can be found in the whole of human body and with this facility the snake can perceive the characteristics of an object.

Another fascinating sense is the echo-location system of some species of bats, used for detecting objects in total darkness. Although the echo receptor is the ear itself, it acts as an eye for the purpose of recognizing an object, its size, shape, texture, position, movement etc. except colour. The only difference is that in most cases an eye uses the available light, whereas these bats have to use their own 'light'-the ultrasonic waves as in the radar.

Many more fascinating senses are dealt with in this small book, but I would rather that the readers get it all first hand from the author himself.

There are also chapters on celestial naviga-

tion used by bees and birds, sense of equilibrium as exhibited in different species in different stages of development, and so on; ending with a discussion on the pineal eye as manifested in the tuatara and many other reptiles.

In addition to describing these 'extra' senses the author also deals extensively with the conventional five senses focusing specially upon their fantastic development in some of the animals. These senses have developed to such an extent that the sense apparatuses we posses appear dim, remote, and absolutely primitive.

An obvious omission in this book is a list of literature consulted by the author. In a book like this, such a list would have greatly helped students and other interested readers who may want to pursue this subject further. There are some disturbing passages in the text such as 'A dog's nose works a million times better than ours' (page-104). A list of literature consulted would have enabled the readers to check up for themselves the validity of such and other statements.

Apart from these minor shortcomings which can be rectified in subsequent editions, this book is a valuable publication worth being kept in all school and college libraries in addition to its being useful to general and specialized readers. It is a book one would find difficult stop reading once having started it.

ROBERT B. GRUBH

MISCELLANEOUS NOTES

1. ON THE OCCURRENCE OF THE COMMON OTTER IN MAHARASHTRA (ITIADOH LAKE—BHANDARA DISTRICT) WITH SOME NOTES ON ITS HABITS

Otters have been reported by local fisherman and shikaris in at least four lakes of Bhandara District (in N. E. Maharashtra in India), Nawegaon Bandh, Gandhari and Palandur constructed about 300 years ago and Itiadoh lake on the Garvi river in 1960. During the past two and a half years I too sighted them in all these lakes and recognized the species as the Common Indian Otter (*Lutra lutra*). A specimen produced to me by a fisherman from the area enabled confirmation of the species by the Bombay Natural History Society.

The Common Indian Otter has not been recorded by Prater (1971 BOOK OF INDIAN ANIMALS), as occurring in these parts, or for that matter anywhere except in Kashmir and southern India. The smooth-coated Indian Otter (*Lutra perspicillata*) too has been recorded only once in 1826 within the limits of Maharashtra (1974, MAHARASHTRA STATE GAZETTEER p. 354).

Food and Breeding Habits:

Some food and breeding habits of the Common Indian Otter which I have occasion to observe very frequently is summarized below.

The principal diet as recorded by Prater (1971) is fish which may occasionally be substituted by frogs. The animals come out on to the land near the back waters to feed upon abundant *Vetiveria zizanioides.* Common teal (*Anas crecca*), Lesser whistling teal (*Dendrocygna javanica*), Little cormorant (*Phalacrocorax niger*), White breasted waterhen (*Amaurornis phoenicurus*), Purple Moorhen (*Porphyrio porphyrio*), & Water Cock (*Gallicrex cinerea*). Ducks and Cormorant are seized in water and White breasted waterhen, Purple moorhen and Water Cock in wild rice (*Oriza sativa*).

They gather near fishing lines after sunset, and when one discovers a fish caught in any of the hooks, it whistles attracting four or five other individuals (possibly immediate members of its family?) and the group gorges on the fish stopping just below the head to avoid contact with the hook.

Breeding:

The nursery or 'holt' is on the bank of Itiadoh Lake. Formerly this particular spot on the bank of the river Garvi was known as Pokhar Dongari (locally meaning hollow hills) now partly submerged under the Itiadoh Lake. It has several entrances, one of them under water, a favoured breeding ground for these animals. Young ones are born blind in January-February and do not open their eyes for 2-3 days and remain in the tunnel for about a month. They can move independently after $1\frac{1}{2}$ months. The mother feeds them on fish brought in her mouth. At birth they are of the size of a newly born kitten or an adult rat. The young were once found playing in the hollow of dead-decaying logs lying in the submerged areas with the mother relaxing on the log in the early hours of the morning. They remain with the parent until they can hunt and feed independently. The same tunnels are used earlier (Nov.-Dec.) by Porcu-

pines for breeding.

Bhandara District also known as the lake district of Maharashtra has several lakes. It is therefore very likely that there are other strongholds of this Otter within the District. This however needs further investigation.

M. B. CHITAMPALLI

SUB-DIVISIONAL FOREST OFFICER,
NAWEGAON NATIONAL PARK,
NAWEGAON BANDH,
DIST:— BHANDRA, (M.S),
June 20, 1978.

2. EVIDENCE FOR A TIGER EATING A PANTHER CUB

In general predators tend to be intolerant of each other even to the extent of killing without provocation — and not just at kills (Schaller 1972). It has been recorded that tigers are intolerant of leopards (Anderson 1961) and the encounter some times may be fatal for the leopard (Allen 1960). Leopards killed may also be eaten by the tiger (Anderson 1954). Many of these type of findings in the Indian Jungle are obviously based on indirect evidence as the dense vegetation, the shy nature of the animals and the element of danger involved in going close to the animals seldom allow a field worker to witness the skirmish from the beginning to the end.

On 12.3.1978 an elephant mahout had seen a tiger in a bamboo-clad dry stream bed a kilometre from Bandipur Campus. When I was told about this, suspecting a kill, I combed the area in the company of Keechanna my tribal boy the next morning. Jungle crows were hovering over that area and while walking through the dense stand of bamboo I saw a panther lying on a *Terminalia bellerica* tree 10 - 12 metre from me. Cursing myself for not having brought the camera I slowly and silently retreated. My withdrawal enabled Keechanna to see the panther. Soon he ran to Bandipur to bring my camera and I climbed a tree 100 metres away and waited for 45 minutes watching the crows mobbing the panther.

Keechanna brought not only my camera but also Dr. Madhav Gadgil and two of his students. From a distance I showed them the panther and as all wanted to photograph we stalked through the bamboo but the panther jumped down and ran away.

Crows were still cawing and I continued my search for the kill. In one place I smelt the kill and the buzzing flies led me to the remains—skull, one lower jaw, one claw and intestine—of a panther cub approximately 3-4 month old. On the grass we could see the hair of the tiger and the panther. Impressions on the grass under a bush also showed the place where the tiger had been lying while eating. Twice it had drunk water in the nearby pool.

Earlier twice I had seen panthers on trees and in one instance, when a tiger was involved, the panther did not even jump down when I climbed a tree 10 metres away. But on the other occasion I saw a panther from 200 metres and hardly had I advanced 100 metres across an open area before the panther got down and ran way. However it should also be mentioned that in both cases where tigers were involved I had accidentally approached the panther through dense vegetation.

RESEARCH SCHOLAR,
BANDIPUR TIGER RESERVE,
MYSORE, INDIA,
July 7, 1978.

A. J. T. JOHNSINGH[1]

REFERENCES

ALLEN, H. (1960): The lonely tiger, London.

ANDERSON, K. (1954): Nine man-eaters and one rogue. London.

———— (1961): The call of the man-eater. London.

SCHALLER, G. B. (1972): The serengeti Lion—A study of Predator—Prey Relations. University of Chicago Press, Chicago.

[1] *Present address*: Ayya Nadar Janaki Ammal College, Sivakasi, Tamil Nadu.

3. RANGE EXTENSION OF CRABEATING MONGOOSE IN BANGLADESH

Recently (May 1978) three of our postgraduate students of wildlife biology, a wildlife enthusiast and myself were at Bariadhala, near the coast of Bay of Bengal, in Ramgarh-Sitakundu Range of the Chittagong Forest Division in the south-eastern part of Bangladesh We were looking for wild animals along the edges of a moist deciduous forest dominated by *Artocarpus chaplasha, Dipterocarpus turbinatus* etc., where the edges had an abundance of *Grewia, Sterculia, Wrightia, Cycas* etc. There was a pond (100 m by 30 m), covered almost entirely by Indian Lotus. On its southern bank there was a thicket (5 m by 30 m) having some plants of the neighbouring forest with an abundance of *Clerodendrum.* A bridle-path-cum-cattle trail separated the pond from the forest edge.

One of the students (Anwarul Islam) who was searching for a wounded bird which he shot found a mongoose-like animal closely watching from inside the thicket. We encircled the bush and tried to drive the animal out. After about half an hour of beating the jungle the animal came to the open area, between the bush and the pond and again entered the jungle. By that time I took two shots by my Fujica ST701 35mm Camera with a 85-205 mm tele-zoom lens. Unfortunately the sky was overcast and the pictures are not sharp but they clearly show the distinguishing features of a Crabeating Mongoose *Herpestes urva* (Hodgson). The white patch running from the mouth to the shoulder on either side, its massive build and erectile body and tail hairs are quite conspicuous. The latter feature must have been a defensive posture or threat display.

Two species of Mongoose are known to occur in Bangladesh. They are the Common Mongoose *Herpestes edwardsi* (Geoffroy) and Small Indian Mongoose *H. auropunctatus* (Hodgson), both are common. But there appears to be no record of the Crabeating Mongoose occurring in this part of the sub-continent or of West Bengal. Blanford (1888), Pocock (1939-1941), Ellerman and Morrison-Scott (1951), have not included Bangladesh (or Bengal) that is erstwhile East Pakistan in the distributional range of the Crabeating Mongoose. Authors like Mountfort (1968) and Husain (1971) who have worked the Bangladesh fauna also did not include this species in their record. Prater (1971) states that it oc-

curs from Nepal to Assam, eastwards to Burma, south China and the northern part of Malaya. Therefore this is first record of the occurrence of *Herpestes urva* in Bangladesh. The distributional range of this species can now be extended from the neighbouring Assam and Burma to almost the coast of the Bay of Bengal across Chittagong.

ACKNOWLEDGEMENT

I thank the Forest Department officials, Mr. Shah Ali Imam, DFO, in particular, of Chittagong Forest Division for their various help: and to Messers Anwarul Islam, Saiful Hoque, Gazi Syed Asmat and Bablu for their assistance.

M. A. REZA KHAN

DEPT. OF ZOOLOGY,
UNIVERSITY OF DACCA,
DACCA-2, BANGLADESH,
May 29, 1978.

REFERENCES

BLANFORD, W. T. (1888): The fauna of British India, including Burma and Ceylon: Mammalia. London, Taylor and Francis.

ELLERMAN, J. R. AND MORRISON-SCOTT, T. (1951): Checklist of Palaearctic and Indian Mammals 1759-1946. London, British Museum.

HUSAIN, K. Z. (1974): An introduction to the wildlife of Bangladesh. Dacca, F. Ahamed.

MOUNTFORT, G. (1968): Our vanishing Jungle. London, Collins.

POCOCK, R. I. (1939-1941): The fauna of British India, including Ceylon and Burma: Mammalia, 2 vols. 2nd edn. London, Taylor and Francis.

PRATER, S. H. (1971): The book of Indian Animals. 3rd rev. edn., India, Bombay Natural History Society.

4. AN INTERESTING BEHAVIOUR OF THREE NILGIRI TAHR (*HEMITRAGUS HYLOCRIUS* OGILBY 1833) KIDS

On 3rd March 1978 I accompanied Mr. John Joseph, Wild Life Warden, Mudumalai Wild Life Sanctuary and Mr. Radcliffe, Nilgiri Wild Life Association, to the Nilgiri Tahr country. Our intention was to look for poachers. The previous day, Mr. John Joseph had sent a reconnaissance party and our plan was to meet them beyond Bangitappal in the interior of the Tahr Country. After our rendezvous with the advance party we went to Nadgani to see the precipitous slope leading into the Nilambur valley of Kerala from where poachers, using a long cane as a rope, frequently came to steal cane and to shoot.

On the way to Nadgani we saw 13 adult Tahr on a slope. Nearly a kilometre after the sighting, 3 Tahr kids with 4 - 5 cm long horns, probably separated from the parental herd, seeing us walking in a single file, ran towards us. Seeing them coming towards us we stood still on the bridle path and one of the three kids came as close as 6 metres to our Khaki clad troop. However after some time we started walking and the tahr instead of running away, occasionally bleated and followed us. Many a time the wind blew our scent to the kids and that also did not frighten them. The young which came close to us first mostly maintained a distance of 8 - 10 metres and followed us for well over a kilometre.

A. J. T. JOHNSINGH[1]

RESEARCH SCHOLAR,
BANDIPUR TIGER RESERVE,
KARNATAKA, INDIA,
July 19, 1978.

[1] *Present address*: Ayya Nadar Janaki Ammal College, Sivakasi, Tamil Nadu.

5. A SUPPLEMENTARY NOTE ON SOME MAMMALS RECENTLY COLLECTED IN BHUTAN

During the last decade, Dr. B. Biswas of the Zoological Survey of India, Dr. Salim Ali of the Bombay Natural History Society, and Dr. S. Dillon Ripley of the U.S. National Museum, Washington, have conducted faunistic explorations in the montane kingdom of Bhutan during several trips.

The mammalian collections made by Dr. B. Biswas have been reported upon by Chakraborty (1975)and by Saha (1978).

The present paper, however, deals with the valuable mammalian collections made by Dr. Salim Ali and his party. The collection under report, comprises of 14 examples belonging to 10 species. Four species, namely *Cynopterus brachyotis angulatus* Miller, *Rhinolophus pearsoni pearsoni* Horsfield, *Hystrix hodgsoni hodgsoni* (Gray) and? *Rattus jerdoni* (Blyth) were taken for the first time in Bhutan.

Family Pteropidae

Cynopterus brachyotis angulatus Miller

Cynopterus angulatus Miller, 1898. Proc. Acad. Nat. Sci. Philadelphia,

316. Type Locality Trang, Lower Siam.

Material: 1♀; Nr. Phuntsholing, alt. *c.* 610 m, W. Bhutan. 7 Oct. 1968.

Measurements: External: Head and body 98. Forearm 54. Ear 22. Tail 10. Hindfoot 6. Cranial: Greatest length 30. Rostrum 7.

Remarks: Although Hill and Thonglongya (1972) treated Miller's *Cynopterus angulatus* as a subspecies of *C. sphinx*, I prefer to follow the general treatment to keep it under *C. brachyotis* as by most authors.

The present specimen is, however, the first one taken in Bhutan.

Family Rhinolophidae

Rhinolophus affinis himalayanus Andersen

Rhinolophus affinis himalayanus Andersen, 1905. Proc. zool. Soc. 1905, 2 : 103.

Type Locality Mussoorie, Uttar Pradesh, India.

Material: 1♀; Gedu, alt. *c* 1830 m, W. Bhutan. 11 Oct. 1968.

Measurements: (From the stuffed skin) Forearm 49.4. Ear 16.9.

Rhinolophus pearsoni pearsoni Horsfield

Rhinolophus pearsoni Horsfield, 1851. Cat. Mamm. Mus. E. Ind. Co. 33.

Type Locality Darjeeling, West Bengal, India.

Material: 1♂ (skin only); Phuntsholing, alt. *c* 610 m, W. Bhutan. 7 Oct. 1968.

Measurements: (From the stuffed skin) Forearm 53.6. Ear 25.8.

Remarks: Ellerman and Morrison-Scott (1966) gave Kumaon, Darjeeling, Assam (Dobson), Szechuan and Yunnan as its approximate distribution. The present specimen is the first one taken in Bhutan.

Family Viverridae

Viverra zibetha zibetha Linnaeus

Viverra zibetha Linnaeus, 1758. Syst. Nat. 10th ed. 1:44. Type Locality Bengal.

Material: 1♂ (skin only); Batase, alt. *c* 1525 m, C. Bhutan. 11 Mar. 1967.

Family Cervidae

Muntiacus muntjak vaginalis (Boddaert)

Cervus vaginalis Boddaert, 1785. Elench. Anim. 1: 136. Type Locality Bengal.

Material: 1♂; Shamgong, alt. *c* 1981 m, C. Bhutan. Apr. 1967. 1♂ (skin only), 1♀; no locality, but from the other data of its collection (Oct. 1968, when the expedition was carried out in W. Bhutan), it appears to have been collected in W. Bhutan. Oct. 1968.

Family SCIURIDAE

Tamiops macclellandi macclellandi (Horsfield)
Sciurus macclellandi Horsfield, 1839. Proc. zool. Soc. 152. Type Locality Assam.

Material: 1 ♂; Chapcha, alt. *c.* 2450 m, W. Bhutan. 13 Nov 1968.

Dremomys lokriah bhotia Wroughton
Dremomys lokriah bhotia Wroughton, 1916. J. Bombay nat. Hist. Soc. 24: 634. Type Locality Sedenchen, Sikkim, India.

Material: 1 ♂, 1 ♀; Chimakothi, alt. *c.* 2440 m, W. Bhutan. 5 Nov, 8 Nov 1968.

Ratufa bicolor gigantea (McClelland)
Sciurus gigantea McClelland, 1839. Proc. zool. Soc. 150. Type Locality Assam.

Material: 1 ♀; Batase, alt. *c* 1525 m, C. Bhutan. 11 Mar 1967. 1- (skin only without any other data).

Family HYSTRICIDAE

Hystrix hodgsoni hodgsoni (Gray)
Acanthion hodgsoni Gray, 1847. Proc. zool. Soc. 101. Type Locality Nepal.

Material: 1 ♂ (skin only); Chapcha, alt. *c* 2440 m, W. Bhutan. 13 Nov 1968.

Remark: This specimen is the first one taken in Bhutan.

Family MURIDAE

? Rattus jerdoni (Blyth)
Leggada jerdoni Blyth, 1863. J. Asiat. Soc. Bengal, 32: 350. Type Locality Sikkim.

Material: 1 ♂ (skin only); Shamgong, alt. *c* 1918 m, C. Bhutan. 17 Apr 1967.

Measurements: (From the stuffed skin) Head and body 123. Tail 163. Hindfoot 26. Ear 20.

Remarks: The Bicoloured Rat is exceedingly rare and very few specimens have so far been collected. The taxonomy of this species is controversial. Detailed discussion on its taxonomy is being dealt with separately. Although the skull of the specimen was not available, I could not, but, place it under this species.

This specimen is, however, the first one taken in Bhutan.

ACKNOWLEDGEMENTS

I am indebted to Dr. B. Biswas for his keen interest in this work and for kindly going through the manuscript. Sincere thanks are due to Dr. Salim Ali and to Shri J. C. Daniel for lending the collections for my study.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA,
October 19, 1978.

SUBHENDU SEKHAR SAHA

REFERENCES

BLYTH, E. (1863): A Memoirs of the Rats and Mice of India. *J. Asiat. Soc. Beng., 32*: 350.

CHAKRABORTY, S. (1975): On a collection of mammals from Bhutan. *Rec. zool. surv. India, 68*: 1-20.

ELLERMAN, J. R. AND MORRISON-SCOTT, T. C. S. (1966): Checklist of Palaearctic and Indian Mammals. Brit. Mus., London.

HILL, J. E. AND THONGLONGYA, K. (1972): Bats from Thailand and Cambodia. *Bull. Brit. nat. Hist.* (zool)., *22* (6): 173-196.

SAHA, S. S. (1978): On some mammals recently collected in Bhutan. J. *Bombay nat. Hist. Soc., 74* (2): 350-354.

6. OCCURRENCE OF CHESTNUTHEADED BEE-EATER (*MEROPS LESCHENAULTI*) IN BOMBAY

On 30th August 1978, while bird watching in Borivli National Park, we saw two Chestnutheaded bee-eaters (*Merops leschenaulti*) on overhead electric wire near the Bacon Factory *nalla*, on the way to Lion Safari Park. There were also a few Common green bee-eaters (*M. orientalis*) on the same wire but at *c* 10 metres from the Chestnutheaded bee-eaters which facilitated comparison. The Chestnutheaded bee-eaters were slightly larger, with a prominent bright yellow patch covering the chin and throat and a chocolate coloured cap. We did not see the back of the specimens. The absence of long pin feathers of the tail indicated beyond doubt the identity of the birds.

According to Ripley (1961, SYNOPSIS) the species occurs "from the plains to 5000 feet, in well wooded country" and in the stretch along the west coast of India it has not been recorded north of Belgaum. Sálim Ali and Ripley (1970; HANDBOOK 4, p. 100) state that the species occurs "Also in the Western Ghats complex, from about Goa southward (including western Mysore, Western Tamil Nadu and Kerala) and Ceylon". Humayum Abdulali (1971; CHECKLIST OF THE BIRDS OF MAHARASHTRA) has marked the species as being occasionally sighted "either in Ratnagiri and/or Mahabaleshwar" and its migratory or residential status as undecided. However, after verifying his notes H.A. (personal communication) has indicated (on the basis of Hume's foot note in *Stray Feathers*, Vol: IX, p. 49) that the only records of Chestnutheaded bee-eater from Maharashtra are from Vengurla (appreciably south of Ratnagiri) where a Capt. Bingham found it common in January.

The present sight record of the Chestnutheaded bee-eater in Borivli National Park, Bombay is an extension of its known distribution range.

CURATOR (WILDLIFE),
BORIVLI NATIONAL PARK,
BOMBAY-400 066.

P. KANNAN[1]

U. S. FISH AND WILDLIFE SERVICE,
WASHINGTON, U.S.A.,

G. BERTRAND

September 28, 1978.

[1] *Present address*: Asst. Director (Wild Life Preservation), Govt. of India, Wild Life Regional Office, 11 Air Cargo Complex, Sahar, Bombay-400 057.

7. BEEHIVE PREDATION BY WASPS (GENUS *VESPA*) AND ITS POSSIBLE BENEFIT TO HONEYGUIDES (INDICATORIDAE) IN BHUTAN

Cerophagy or wax eating habit of many species of Honeyguides in Africa and Asia has been known for quite some time. Some species of honeyguides in Africa are known to have developed symbiotic relations with man and other animals to secure beeswax from hives inaccessible to the birds themselves. Several other species of honeyguides are also

known to take beeswax along with other insects though how they obtain the wax is not clear. Since bees would actively defend their nests the birds perhaps get their wax either from the combs abandoned by the bees or on the leavings of other bee hive predators.

Iwata (1976 EVOLUTION OF THE INSTINCT: COMPARATIVE ETHOLOGY OF HYMENOPTERA) mentions the behaviour of the Genus *Vespa* and states that several species of this family attack the nests of honey bees and other wasps, indiscriminately killing their larvae, pupae and adults. Friedmann (1955 The Honeyguides. *United States National Museum Bulletin* 208: 292 pp.; 1972 The Asian Honeyguides. *J. Bombay nat. Hist. Soc. 71*: 426-432.) has discussed the various aspects of beeswax eating and guiding habits of the Indicatoridae. While information about Asian honeyguides is meagre, all the data given in Friedmann's papers relate to cases where cerophagy by honeyguides in Africa is from inaccessible bee hives after their being opened up by other predators. Many possible bee hive predators are discussed but there is no mention of predatory insects. Information is also not available whether honeyguides feed on exposed (abandoned bee combs) or of the birds' occurrence at such sites in any numbers.

In May-June one of us (SAH), and again in October-November 1977 we visited central Bhutan to study the ecology of the Orange-rumped Honeyguide (*Indicator xanthonotus*), sponsored by the Society's Sálim Ali Nature Conservation Fund. Most of our studies were carried out around clusters of hives of the giant Rock bee (*Apis dorsata*) situated at 'Honey Rock' *c* 5500 ft in Central Bhutan.

During the course of our study in October-November, we noticed several large wasps (specimens later identified at the British Museum as *Vespa mandarina magnifica*) attacking active bee hives. Four or five wasps would attack a nest while the bees would actively defend the same. Occasionally there would be fierce 'dog fights' between the bees and the wasps resulting in the death of a few wasps and many bees. On 24 October we observed a great deal of activity around a particular bee nest. A large number of wasps had centerated their attack on this nest while the bees, now seriously disturbed, were swarming all over the rock face trying to ward off the attackers. The battle went on for quite 10 minutes with the bees obviously having the worse of exchanges. Slowly the yellowish white wax structure of the upper basal part of the bee comb became visible as the bees started vacating the nest. The wasps now concentrated their attack on this portion of the comb with greater vigour. After a few minutes the bees vacated the entire comb and continued to hover near the rock face. The assembly slowly drifted away from the rock and disappeared *en masse* down the ravine. The wasps then settled on the exposed bee comb and started digging out larvae and pupae. While the above activities were in progress the honeyguides had kept away from the rock face. Once the comb was exposed several honeyguides arrived on the scene and perched at various places on the cliff face. A few birds tried to approach the exposed comb but were chased away by the wasps. After the wasps had finished feeding and had vacated the comb several honeyguides settled on it and commenced feeding on the wax.

Our studies in Bhutan reveal that Orange-rumped Honeyguides feed on old bee combs occurring among active exposed hives of *Apis dorsata* on rock cliffs. They also feed on scraps of pure wax adhering to cliff faces or on old combs fallen below the cliff. The birds generally congregate near traditional bee nesting sites. E. J. Cronin and P. J. Sherman (1976 A resource based mating system—Or-

angerumped Honeyguide. THE LIVING BIRD) have also reported on the Wax eating habits of this species in eastern Nepal.

ACKNOWLEDGEMENTS

We thank Dr. C. R. Vardy of Dept. of Entomology, British Museum for identifying the wasps and also Dr. S. Dillon Ripley, Secretary, Smithsonian Institution and Dr. Karl V. Krombein, Dept. of Entomology, National Museum of Natural History, Washington, for useful suggestions and for relevant literature.

S. A. HUSSAIN
SALIM ALI

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
BOMBAY-400 023,
December 26, 1978.

8. A NOTE ON THE PREDATION OF JUNGLE MYNA (*ACRIDOTHERES FUSCUS* WAGLER) ON FIELD MOUSE

On the evening of 2nd June 1978 I was watching for wild dogs and at 1746 hrs. a jungle myna alighted on the ground 30 metres away from me and caught an ashy white animal. When I carfeully observed it with binoculars I found it to be a field mouse, probably a young. The myna had caught the head end of the mouse and battered it repeatedly. Occasionally the bird screeched as if it had got into a trouble by tackling an unusual prey. By 1749 hrs. the mouse appeared to be dead and the myna, after having placed it on the ground and (battering) shaking it throughly, flew off and dropped it in to its nest hole on an *Albizzia odoratissima* tree at a height of 9-10 metres. Later when I moved from the original place I could see the gaping mouths of two nestlings but I was uncertain whether the mouse was swallowed by a chick. Once I saw a crow-pheasant hopping along a water edge trying to catch frogs, which I thought was to be expected. But the ability of a myna to kill a mouse was something I never expected.

A. J. T. JOHNSINGH[1]

RESEARCH SCHOLAR,
BANDIPUR TIGER RESERVE,
MYSORE, INDIA,
July 26, 1978.

(Baby mice have been recorded as an occasional food item in the INDIAN HANDBOOK, 5: 179—EDS).

[1] *Present address*: Ayya Nadar Janaki Ammal College, Sivakasi, Tamil Nadu.

9. THE NESTING OF TICKELL'S FLYCATCHER (*MUSCICAPA TICKELLIAE*) IN BOMBAY

Many years ago Betham took eggs of Tickell's Blue Flycatcher (*Muscicapa tickelliae*) at Poona in July/August and Davidson on Kondabhari Ghat, near Dhulia, in July. In NIDIFICATION (2 : 202), Stuart Baker presumably with additional data, said it bred at Poona and the Western Ghats from May/June to August.

In 1937, in "Birds of Bombay and Salsette" (*JBNHS 38*: 525), Sálim Ali and I recorded the species as common in the better wooded and forested parts of the island from October to May, and added that while it was certain that some at least remained in our area during the monsoon, it was evident that the majority went away to breed. Notes over subsequent years have confirmed these observations in general, but no definite evidence of their nesting in the Konkan, west of the Ghats was available.

It was therefore a pleasant surprise to learn that my sister Mrs. Sakina Moizuddin had found a nest in her garden at Chembur, Trombay, Greater Bombay, and the following notes kept jointly with her may be of interest:

The cup-shaped nest of vegetable fibres was placed in a niche in a rotten tree stump, 18 inches from the ground, and a few feet away from the door leading from her house into the garden. The nest was given away by the bird rushing off when the door was used, and resulted in the door staying closed for the duration of the nesting. The nest was visible from an adjoining window, but too close for focussing my binoculars.

The first egg was seen on 28th July 1977, two at 8-30 a.m. on 29th and the full clutch of 3 on 30th.

On 30th July, a bird with bright blue eyebrows was on the nest at 9 a.m. and also at 9 p.m.

During this period my sister got the impression that the hen(?) was sitting on the nest the whole day, while the male turned up at odd intervals and sang among the trees 15 yards away. Both birds were not seen together.

10th August: Three chicks noted today, 11 days after completion of clutch. The mother had been sitting exceptionally close over the last day or two, during which time, the male, who was a brighter chestnut in front and a brighter blue above, also appeared to stay longer around the area.

13th August: *c. 6-30 p.m.*: Three hair-covered chicks lay flat and motionless in nest. The female with much paler underparts, fed the young while the male sat on a branch 15 yards away. At 7-30 p.m., and again at 9-30 p.m., there was no parent on the nest. Nor was either seen settled on the nest after the chicks had hatched.

14th August: Both parents carrying food to nest, perching at about the same place in a climber *c.* 5 ft from the nest, for an all-clear look before actually visiting it. The same perch was often, but not always, used on the return. Between 2-30 and 3-30 p.m., they visited the next 10 times, male 4, female 6. On the second visit the ♂ flew away from the preliminary perch and failed to come back for half an hour. The ♀ visited at intervals of about 10 minutes. Both were at the perch together only once, Caterpillars appeared to be the most frequent food.

20th August: I arrived at about 6-30 p.m., and was told that all three young had been seen in the nest half-an-hour back. The ♂ was seen with food but appeared reluctant to visit the nest, and I thought I would ring the birds as scheduled and watch them later. The nest was found to hold only one chick with a half-grown tail and the brown pale-spotted plumage of juvenile flycatchers. A green plastic ring was placed on its foot but it refused to stay in the nest and fluttered to the ground near the closed door. The male flew around, with food and calling, but did not appear to be doing anything. After about 10 minutes, the female appeared for the first time, flew to the nest and then the chick, and persuaded it to hop along the ground for about 15 ft

where it squatted on the lawn. The male continued his earlier behaviour, but finally settled beside the chick and thrust a small dragonfly down its throat. After another 10 minutes he appeared with a large gryllid(?), settled near the chick but did not feed it, apparently trying to entice it further away into some bushes. The chick finally hopped away, with the male still holding the mole-cricket.

Almost an hour had passed and as the birds could no longer be seen, the watch was discontinued. It is assumed that the hen was not very far away, looking after and feeding the other two chicks.

Throughout the period at the nest the feeding started at sunrise and continued till after sunset. The ♂ was never seen on the eggs and was more constantly singing than attending to the young. Neither parent was actually seen carrying away any droppings, but this was no doubt done, for the nest was quite clean when abandoned.

The chicks were not heard to utter any call from the nest, and usually lay limp and motionless when touched by hand, though all gaped eagerly when a parent approached with food.

After leaving the nest, both parents were now and then seen in the garden for several days (last on 26th August) with the male still singing though not as vigorously as before. Of the young, single birds were seen only twice, and they all appear to have moved out of the garden.

During the above period, we found in the same garden and within a radius of 25 yards, nests of the Crow-pheasant, White-eye, Purplerumped Sunbird, Red-whiskered Bulbul and Whitespotted Fantail Flycatcher. Though several nests of the White-eye have been found on the adjoining mainland (April to September), this nest (with young on 21st August) discovered by S. R. Nayak, is the first definite record from Salsette. This apparent concentration of nesting birds, if real, may be due to the destruction and disappearance of suitable habitats in the surrounding areas.

HUMAYUN ABDULALI

75 Abdul Rehman Street,
Bombay-400 003,
September 5, 1977.

10. NEW RECORDS OF BIRDS FROM ORISSA

While working out a collection of birds from the Orissa State made by Shri P. K. Das in May-June, 1972 and by me in March-April, 1976 and February-March, 1977, I came across examples of four species of birds, namely, *Otus scops sunia* (Hodgson), *Jynx torquilla himalayana* Vaurie, *Prinia socialis stewarti* Blyth and *Arachnothera longirostris longirostris* (Latham), which according to the standard literature on Indian ornithology like Baker (1924, 1926 and 1927), and Ali and Ripley (1969, 1970, 1973 and 1974), have not so far been reported from Orissa.

1. NORTH INDIAN SCOPS OWL *Otus scops sunia* (Hodgson) (Strigiformes: Strigidae).

Material.—1 ♂, 1 ♀; Madpad, Koraput dist.; February 18, 1977.

Measurements.—Wing ♂ ♀ 137; bill from skull ♂ ♀ 21; tail ♂ 60, ♀ 62 mm.

Distribution.—According to Ali & Ripley (1969) its range includes the lower Himalayas from the Afghan frontier in West Pakistan eastward through Chitral, Kashmir, Himachal

Pradesh, Garhwal, Kumaon, Nepal, Sikkim, Bhutan and Arunachal Pradesh. It is also found in the Gangetic plains south to Madhya Pradesh and eastern Maharashtra (Nagpur) east to Assam north and south of the Brahmaputra river, Nagaland, Manipur and Bangladesh.

This is the first record of this species from Orissa.

2. HIMALAYAN WRYNECK *Jynx torquilla himalayana* Vaurie (Piciformes: Picidae).

Material.—1 ♂; Charmal, Sambalpur dist.; March 27, 1976.

Measurements.—Wing 87; bill from skull 17; tail 71 mm.; wt. 32 g.

Distribution.—According to Ali & Ripley (1970) it breeds in the North-west Himalayas from the Kurram Valley to Chitral, Gilgit, Ladakh, Baltistan, Kashmir and Himachal Pradesh. The winter ranges have not been worked out.

The subspecies has not been reported from Orissa so far, and the present specimen constitutes its first record from this region.

3. NORTHERN ASHY WREN-WARBLER *Prinia socialis stewarti* Blyth (Muscicapidae: Sylviinae).

Material.—3 ♂, 2 ♀; Kotagarh, Phulbani dist.; February 22 and 24, 1976.

Measurements.—Wing ♂ 48, 49, 52, ♀ 47, 49; bill from skull ♂ 14(3), ♀ 14, 15; tail ♂ 57, 66, 71, ♀ 58, 62 mm.

Distribution: According to Ali & Ripley (1973), this subspecies is known from Pakistan in the plains of the upper Indus river system, and northern India from the Himalayan foothills, south through the Gangetic plains, northern Madhya Pradesh and eastern Rajasthan to the Kathiawar peninsular, the Narmada river and southern Bihar. The occurrence of the present examples in Kotagarh, Orissa, extends its range further southward.

4. LITTLE SPIDERHUNTER *Arachnothera longirostris longirostris* (Latham) (Passeriformes: Nectariniidae).

Material.—1 ♂, 3 ♀; Kotagarh, Phulbani dist.; May 24 and June 4, 1972.

Measurements.—Wing ♂ 68, ♀ 60, 62(2); bill from skull ♂ 35, ♀ 30(2), 32; tail ♂ 43, ♀ 35, 37, 38 mm.

Distribution.—According to Ali & Ripley (1974), this subspecies is known from the Sahyadri or Western Ghats complex of southwestern India from North Kanara south through western Karnataka, Kerala and Western Tamil Nadu. It is also reported from the Eastern Ghats (Vishakhapatnam district) and from the extreme southeastern Nepal, Darjeeling and Jalpaiguri districts of West Bengal, Bhutan, Arunachal Pradesh, Meghalaya, Nagaland, Manipur, and Bangladesh.

This is the first record of this species from Orissa.

N. MAJUMDAR

ZOOLOGICAL SURVEY OF INDIA,
INDIAN MUSEUM,
CALCUTTA 700 016,
July 4, 1977.

REFERENCES

ALI, S. & RIPLEY, S. D. (1969, 1970, 1973, 1974): Handbook of the birds of India and Pakistan, together with those of Nepal, Sikkim, Bhutan and Ceylon. *3* : 262; *4* : 170; *8* : 57; : *10* : 52. Oxford University Press, Bombay.

BAKER, E. C. S. (1924, 1926, 1927): Fauna of British India, Birds. *2* : 531; *3* : 418; *4* : 435. Taylor & Francis, London.

11. CAPTIVE REARING OF MARINE TURTLES

(*With two plates*)

Introduction and Summary:—The Madras Snake Park Trust began sea turtle studies in 1972 on the Coromandel coast near Madras where one species, the Pacific (Olive) Ridleys (*Lepidochelys olivacea*) nests in fair numbers. In 1973 Madras Snake Park Trust started India's first hatchery and transferred 11 nests of 1272 eggs from the beach where human, dog and jackal predation is over 90% (Valliappan & Whitaker 1974). During the December-March nesting seasons over the next 4 years, Madras Snake Park Trust collected 197 nests of 21,760 eggs which resulted in 13,059 hatchlings which were released into the sea (Whitaker 1977). Also about 50 nesting females were tagged with numbered monel metal inscribed SEND TAG TO MADRAS SNAKE PARK 600022-INDIA. In April 1977, 15 *L. olivacea* hatchlings were retained for rearing at the Madras Crocodile Bank Trust premises near the sea. During 1977, 2 subadult female green turtles were collected, one from Lakshadweep and one from the Coromandel coast; both were accidentally caught by fishermen in nets. A hatchling Ridley was collected in Lakshadweep in November 1977. In late 1977 a hatchling hawksbill turtle was collected in the Indian Ocean by the Indian Navy and given to the Trust.

The following notes discuss housing, feeding, management and treatment of sea turtles of 3 genera in captivity at a site a few metres adjacent to their natural habitat.

1. *Ridley*—Eggs were collected from a natural nest laid on 12-2-77 and incubated in a simulated nest inside a wire mesh enclosed, partially shaded beach hatchery. Temperatures and approixmate humidity were checked regularly (Bhaskar 1978) 46 days later the eggs hatched and 15 of the 80 hatchlings were retained for rearing. Later, in November 1977, the hatchling Ridley from Lakshadweep was included in the rearing trial. Plastic wash basins (50 cm diameter × 18 cm deep) were used initially with 5 turtles per basin. Water was kept at a depth of 6 cm and care was taken that the basin remained at least 3/4 shaded throughout the day. An experienced Madras Crocodile Bank Trust employee, Miss Mangai was put in charge and their optimum growth rates and relative good health are largely due to her personal efforts. The 5 cm hatchlings began feeding on the 3rd and 4th day on small bits of chopped clams (*Donax* sp). Later, chopped fish (mixed) and small ghost crabs and mole crabs were offered and usually eagerly taken. Though several types of sea grasses, algae, and various vegetable greens were offered the turtles rarely took more than a few sample bites. As the turtles were fed daily the sea water had to be changed daily after feeding. Water is brought to the basins by hand from the sea about 100 metres away. 4 of the hatchlings died within 3 months and 6 were released. The remaining 3 are being reared at this time.

Coloration: The coloration of the juveniles has gone through several changes starting at almost black with a few small white patches on the plastron and edges of flippers. The turtles are now considerably lighter (greenish-grey). The Lakshadweep specimen is still very dark with prominent white patches over each eye. From about the 6th month of growth, the carapace develops sharp edges on

the marginal and vertebral scutes, which, like the knife-like dorsal scutes of some juvenile crocodiles, would serve to deter predators.

Behaviour: The long wing-like flippers of a marine turtle are apparently very vulnerable to attack. We have been several nesting females missing flippers and it is commonly reported in the literature that it is probably due to shark attack. The resting posture of a juvenile Ridley while floating on the surface is apparently protective. The turtle folds its hind flippers over its tail and cloaca, the front flippers are folded back on its carapace, reminiscent of a human with his hands behind his back. The mobility of the front flippers also allows the turtle to "clean" its plastron and carapace. This purposeful and regular brushing of its flippers over the shell appears to the a type of grooming to get rid of the algae, barnacles and other adhering plants and animals which abound in the sea. We have observed this species of turtle using similar flipper movements to stir up the sandy bottom of its pond. We had found prawns and crabs (*Doclea* sp.) in the crop of trawler-drowned Ridleys and several times nesting females came ashore covered in mud, pointing to the likelihood that they use their flippers to stir up the bottom to find prey. The single "nail" on each flipper is well developed and sharp. While handling yearling Ridleys, they at first struggle and repeatedly attempt to scratch the hand that is restraining them with the flipper "nail". At no time have the juvenile Ridleys attempted to bite except when food objects are offered.

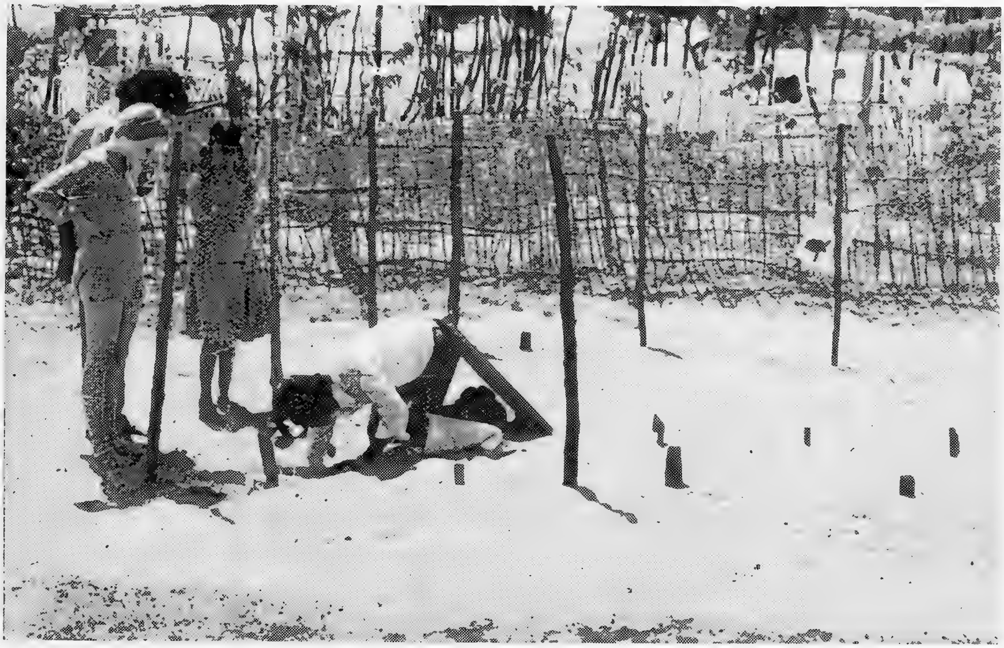
Though used to human presence the turtles are quite timid and are wary but curious at first contact with almost any object.

Floating: The Ridley has been described as being the "highest" floating turtle. All juvenile sea turtles have a higher specific gravity and are apt to bob on the surface unless actually diving with forceful flipper thrusts. The specific gravity gradually decreases and we noticed that at 12-16 months (length 12-18 cm weight 500-800 gm) the turtle is about neutral in sea water and can dive, stay at the bottom or float with equal ease.

Tanks: The plastic basins are still usable for one 25 cm animal. Even though cramped, health, activity and growth rates are acceptable for experimental rearing. Larger asbestos/cement basins (90 cm diam. and 30 cm depth) have been provided. Rubber based paint in several coats has been applied in these basins to prevent abrasion of shell and flippers. These tanks are also manually emptied and filled. The turtles are placed in plastic basins with 10 cms of water at feeding time. After feeding they are rinsed and placed back in the asbestos/cement basins; this system is useful because the water need only be changed twice a week.

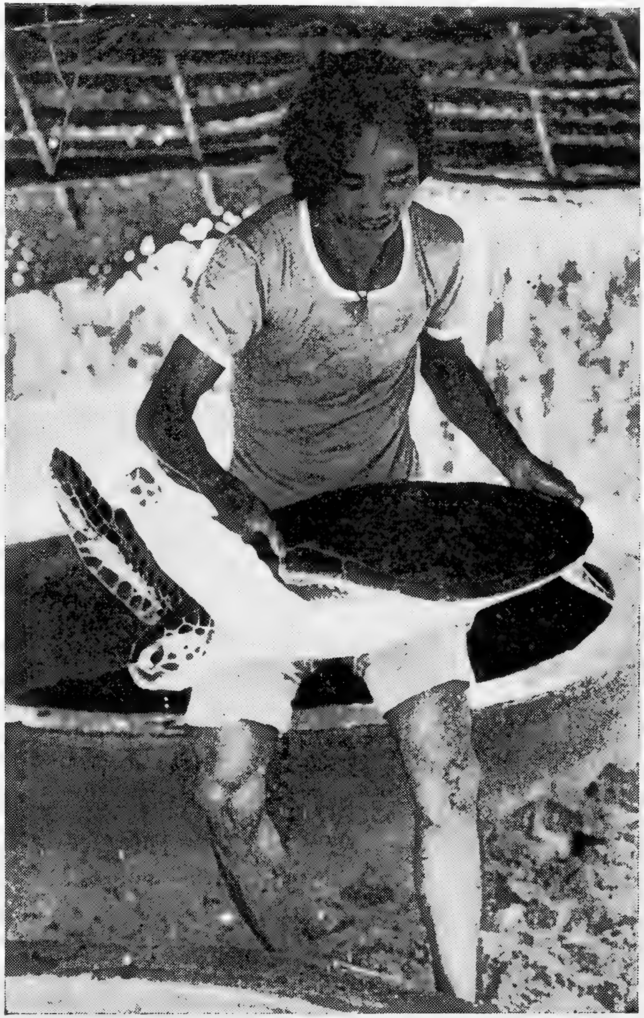
Problems: Keeping the water clean, regularly changed and offering the turtles a wide variety of food as possible (including sea weeds, crabs, shrimp, fish, clams, jelly fish etc.) has assured a fair growth rate and normal health.

The biggest problem so far encountered (and which could have an important implications for turtle farming) is a yellow fungus (possibly *Mucor* sp.). When the hatchling Ridleys were only 7 weeks old the first small yellow dots of fungus appeared on neck and flippers. The yellow patches become larger and are nipped at by other hatchlings. The scabby area may eventually become necrotic and the flipper edge or other affected skin sloughs off. This is especially serious around the eyes and cloaca and can cause death in days. First treatment was with methyl violet, iodine etc. to no avail. Then "Tinaderm" (tolnaftate 1% solution) was used on a rinsed and dried turtle



Above: Recording Ridleys nesting data on Madras beach.
Below: First sea turtle hatchery in India.

PLATE II



Left: Rearing basins and yearling Ridleys. *Right*: Three year old green sea turtle.

which was kept dry for 3 hours after application. This drug resulted in rapid clearing up of the fungus, usually within 7 to 15 days. The younger turtles are more susceptible to fungus attack but recently the yearling from Lakshadweep was affected in the laminae of the carapace. It did not respond well to treatment so "Jadit" solution (Auclosamide and Salicylic Acid) by Hoechat was tried with success after a prolonged healing time of about 2 months.

CHART I

RIDLEY

Measurements on 1-4-77

Carapace (cms) length		C. width	Plastron length	P. width	Headwidth	Weight (gms)
Maximum	5.0	4.2	4.3	3.7	2.1	—
Average	4.9	4.1	4.1	3.6	2.1	20
Minimum	4.8	4.0	4.0	3.5	2.0	—
22-4-77						
Maximum	5.9	5.4	4.9	4.5	2.2	25
Average	5.5	5.1	4.6	4.3	2.2	22
Minimum	5.1	4.6	4.3	3.9	2.1	20
9-9-77						
Maximum	9.5	8.4	8.0	7.1	3.0	175
Average	8.9	8.2	7.6	7.0	2.9	—
Minimum	8.3	7.6	7.5	6.6	2.8	100
20-12-77						
Maximum	14	12	—	—	3.5	600
Minimum	11	10.5	—	—	2.9	360
30-7-78						
Average	18	20	—	—	—	1000
30-12-78						
Maximum	26.5	27	—	—	5.5	2700
Minimum	21	22.5	—	—	5.0	1500

GREENS

30-7-78	CL	CW	HW	WT
A(Madras)	64	62	—	32kg
B(Lakshadweep)	48.5	46	—	16kg
30-12-78				
A	64	62	95	32kg
B	51.5	47.5	8	18kg

HAWKSBILL

	CL	CW	HW	WT
27-6-78	10	10	—	125gms
31-1278	23	22.5	4.5	1500gms

CHART II

Approximate Feeding Schedule (chopped fish, crabs, clams)

			Quantity per day
Hatchling	— 6 months	(5cm to 10cm length)	5-10gms
6 months	— 12 months	(10cm to 16cm length)	10-30gms
12 months	— 24 months	(16cm to 28cm length)	30-65gms

MADRAS SNAKE PARK TRUST,
GUINDY DEER PARK,
MADRAS-600 022,
February 19, 1979.

ROMULUS WHITAKER

REFERENCES

BHASKAR, S. (1978): Turtle Egg Collection, Tiger Paper (FAO). Vol. V, No. 4.

VALLIAPPAN, S. AND WHITAKER, R. (1974): Madras Snake Park Trust publication, Madras.

WHITAKER, R. (1977): A note on sea turtles of Madras. *Indian Forester* 103, No. 11.

12. MALFORMATION AT BIRTH IN THE SALTWATER CROCODILE (*CROCODYLUS POROSUS* SCHNEIDER) IN ORISSA, INDIA

A clutch of 64 eggs collected, gave rise to an abnormal hatchling which now lives along with other normal animals in the hatchling pool of the Salt water Crocodile Research and Conservation Project, located at Dangamal. The abnormality is in both the neck and the tail. A similar type of embryonic deformation occurred in a full term embryo which died without slitting the eggshell (Bustard and Kar, in press) on examination it was found to have a deformed and stunted tail, similar to that described by Bustard (1969) for *Crocodylus novaeguineae* where the cause was thought to be high temperature egg incubation.

The eggs were collected on 30.5.77 from Forest Block No. VIII of Bhittar Kanika Sanctuary and brought to the project hatchery site and hatched between 6.8.77 and 10.8.77. During this period the eggs occupied a middle position in the artificially prepared nest mound inside the hatchery. Egg nest temperature was taken starting from implantation of eggs upto the end of hatching time (measured through a stoppered bamboo pipe permanently inserted in the middle of egg mass) averaged 29.5 (range 37 - 34°C) during 66-70 days incubation period. Fourtyone hatchlings hatched, of which three hatchlings died after 24 hours.

The deformation occurred in both neck and tail portions. The neck is bent to the left at

an angle of about 65-70°C and the tail is twisted. It is possible, though unlikely, that water deficiency could have caused the deformation as has been described for chelonian embryo by Lynn and Ullrich (1950). However, fortyone eggs hatched and produced normal hatchlings. Seven fullgrown embryos failed to hatch due to some abnormality in the neck portion which was very thin. Sixty eggs which failed to hatch were apparently infertile.

Preliminary work, carried out by Bustard indicated that eggs dessicated rapidly when water was not available in the external medium. Here, rain was allowed to fall over the nest to keep the nest slight damp by which the nest can maintain correct temperature by the decomposition of the nesting material. Maximum sunshine was allowed to fall on the nest. The incubation period being in the rainy season it was hard to maintain equal temperature all the time. However, Bustard noted that eggs which had lost approximately 20% of their weight as result of dessication still produced normal hatchlings.

The deformation in both the neck and the tail may be due to high temperatures or may be due to the fluctuation of the temperature at the time of incubation. A detailed study of the water relationship of crocodile eggs of different developmental stages, would reveal the actual cause of deformation.

S. K. KAR

RESEARCH SCHOLAR,
SALT WATER CROCODILE RESEARCH AND CONSERVATION PROJECT,
DANGAMAL-754 220, ORISSA,
October 16, 1978.

REFERENCES

BUSTARD, H. R. (1969): Tail abnormalities resulting from high temperature egg incubation. *Brit. J. Herpetol, 4*: 121-23.

———— (1969): Temperature and water tolerances of incubating crocodile eggs. ibid. 4: 198-200.

LYNN, W. G. & ULLRICH, M. C. (1950): Experimental production of shell abnormalities in turtles. *Copeia*, Ann Arbor, pp. 253-262.

13. SEXUAL ATTRACTION OF A WILD MUGGER (*CROCODYLUS PALUSTRIS* LESSON) TOWARD CAPTIVE MUGGERS

(*With three text-figures*)

Gharial Research and Conservation Unit (GRACU) is situated besides the Satkoshia Gorge of River Mahanadi. The Unit has several enclosure-sets of rearing pools for the gharial (*Gavialis gangeticus*). One such set (RP in Fig. 1 and 2) has a large pool (4m × 4m × 1m) and two small pools (2m × 2m × 0.3m). This enclosure (hence forth to be called as the "Mugger enclosure") is situated at the end of the Project complex; the nearest enclosure, called the Research Pool, being situated at a distance of about 35 metres.

During collection of data for this paper the two smaller pools of the Mugger enclosure

had one mugger each, and the larger pool had three muggers, all male and hatched during the second and third weeks of April, 1975. The muggers measured 138.0 cm to 188.0 cm and weighed 19.1 kg to 38.2 kg on 2-2-78. Usually the pools are thoroughly cleaned once a week, the washings coming out through underground pipes, enter the river.

Close to the mugger enclosure river Mahanadi flows down from south-west. The location of the enclosure in relation to the river (Fig. 3) is shown in Fig. 1 and Fig. 2. The photograph in Fig. 3 has been taken by standing on the river bank in line with the mugger enclosure.

Satkoshia Gorge has three individually identifiable muggers of unknown sex measuring 2.0 to 3.0 m in total length. The Gorge is a 22.4 km stretch of the river, measuring 300-700 m in width. Although no nest has been collected during four consecutive years of observations from 1975 to 1978 breeding seasons, at least one of these muggers is believed to be breeding since mugger hatchlings have been observed during 1976 and 1977. Every year after the flood at least one of the resident wild muggers, the largest of all, is known to frequent or inhabit a tunnel in the river bank. The tunnel used during post-flood season of 1975 had collapsed in 1976; so the mugger had excavtaed a new tunnel on the opposite bank. This tunnel was also used during 1977. The tunnel measured about a metre in height near its entrance; but the length could not be

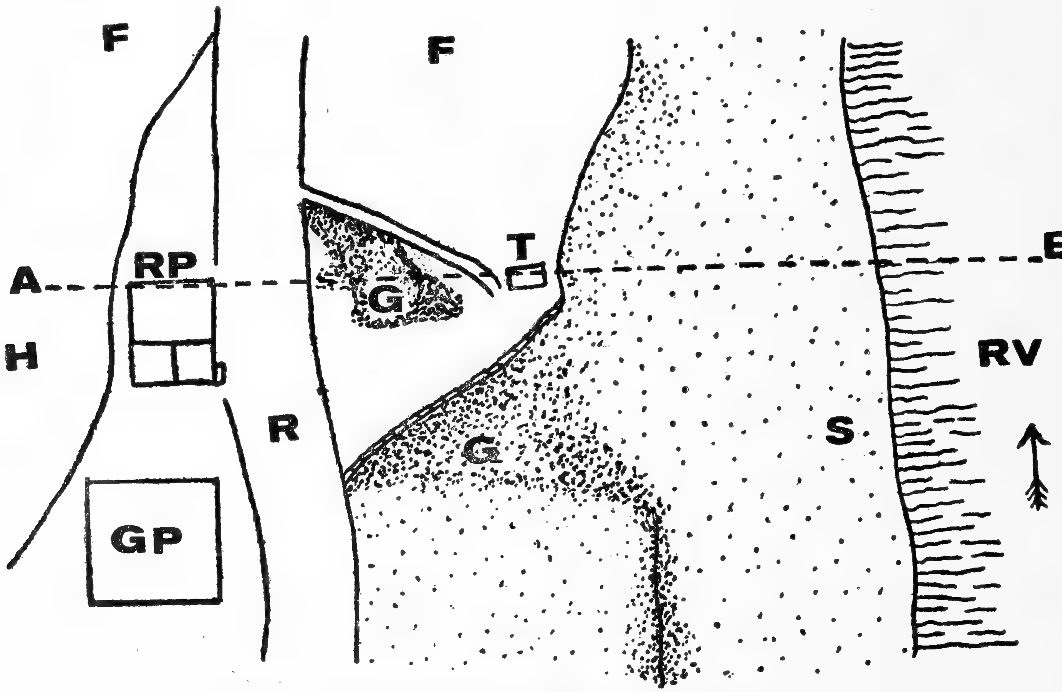


Fig. 1. Ground plan of GRACU near the Mugger enclosure and the adjacent River Mahanadi. A-B = Line of section shown in Fig. 2, F = forest, G = old gully partly filled in, GP = Gharial (Research) Pool, H = hill, R = road, RP = Rearing pool (Mugger enclosure), RV = river, S = sand, T = temple (area: 3 m × 2 m; height 1.5 m above the ground).

assessed properly since a bamboo measuring about 6 m was not adequate to reach the rear end of the excavation. We believe, perhaps the mugger lays her eggs in this tunnel.

However, there are ten trained guards to keep records on the movement of these muggers and the gharials in the gorge. The movement of one of these wild muggers, which measures about 2.8 m in total length, is the purview of the present paper.

Observations

When the water level in the gorge was +109-131 cm above the datum, the mugger under discussion was located once at 12.0 km (28.9.77) and 5.2* km (29.9.77) (the asterisk mark shows that the location is on the right bank when viewed from downstream) from the foot of the gorge; and when the level was 35 cm above the datum it was again located at 12.0 km on 11.11.77.

During December and January, when the water level was from +58.0 cm to –2.0 cm in relation to the datum, the mugger was located near GRACU on a total of four (20th, 25th, 26th and 30th) and seven (9th, 11th, 21st, 22nd, 23rd, 26th and 27th) days respectively. The precise location of its appearance is almost in line with the enclosure (RP: Fig. 1 and 2), about 10 m downstream from the point where the washings from the enclosure enter the river. On these days the mugger is located in shallow water before 2-3 hours of sunrise. When human activities at the Unit begin the mugger moves to mid-stream and surfaces for some time. After about two hours of sunrise our fishermen supplying fish to the Unit return from their overnight fishing and camp at their regular camping site (Fig. 3) which exactly corresponds to the site where the mugger shows up in the early morning. These fishermen leave their camping site at about 4.00 in the afternoon, when the mugger is again seen, on most of the observation-days, at about 0-100 m downstream from the camping site.

From 9th February to 11th February, 1978 the mugger was sighted everyday in the morning and in the evening. On 12.2.78 morning there was an U-shaped track on the sand upto 3 m on the bank from water. The height of the bank from the water was sharply 50 cm.

From this date the camping site of the fishermen was shifted to the other bank of the river. Only at the time of fish-supply they kept their boat at about 200 m upstream the previous site. All the bamboo poles used to keep the nets etc. were removed from the site

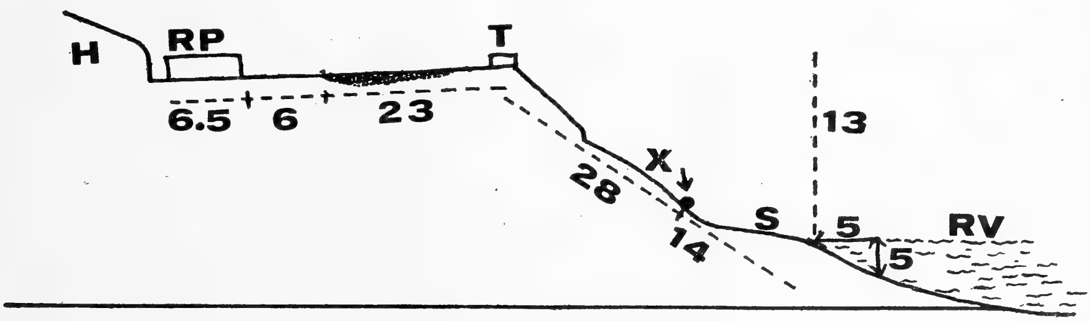


Fig. 2. Cross section of Fig. 1 along A-B. The numerals indicate distances in metres. X = see text, other abbreviations = as in Fig. 1.

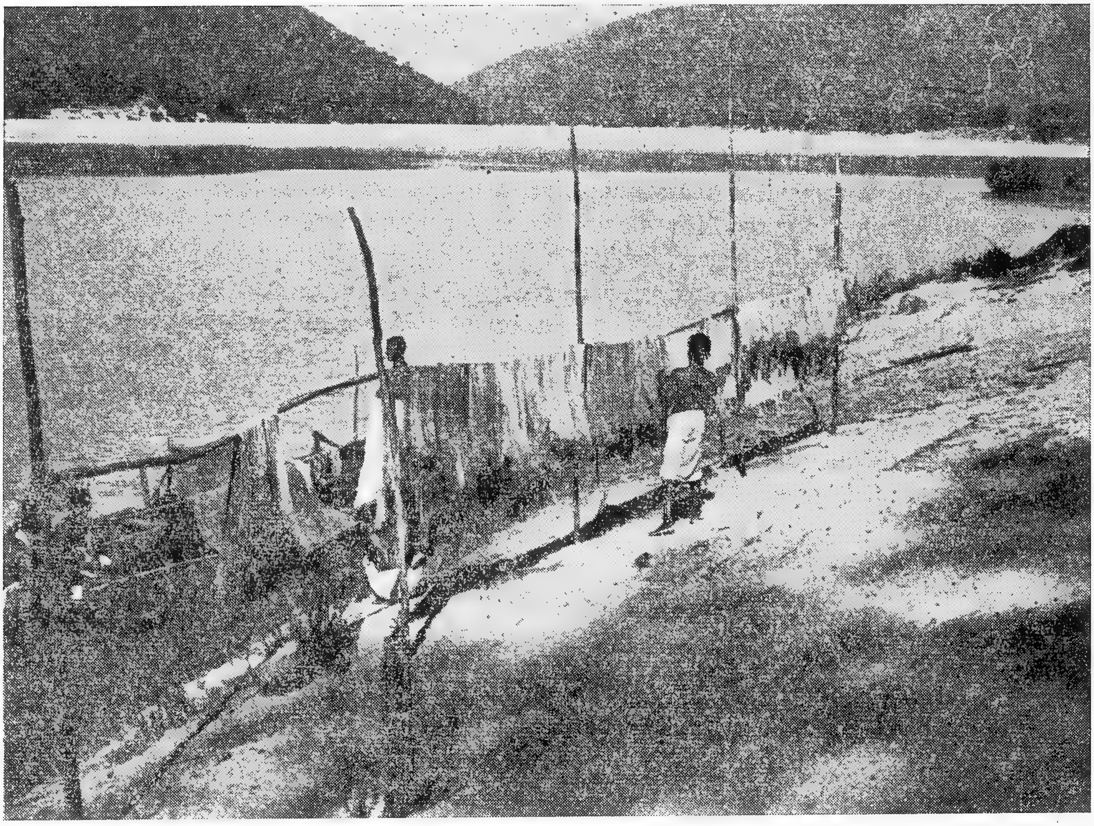


Fig. 3. Photograph showing the river bank down the Mugger enclosure at GRACU. This bank was used by the fishermen of GRACU to camp during the day. Washings from the Mugger enclosure enter the river approximately near the bamboo pole at the rear end of the photograph; and the wild mugger (see text) showed up almost near the first bamboo pole.

and the bank was restored to its normal.

On 12.2.78 afternoon and 13.2.78 the mugger could not be seen any where. But on 14.2.78 morning tracks were seen at the same place on the bank, but leading to the point 'X' (Fig. 2) where there was a heap of dried cut-down *Lantana* branches. Following this observation, the bank upto the temple (Figs. 1, 2) was cleaned from all debris.

On 14.2.78 afternoon and 15.2.78 the mugger was again secretive and it could not be located. On 16.2.78 morning at about 5.30 it was seen lying on the bank at the usual place of its appearance. Upon noticing our activities it entered water. When we went to the bank, we saw the emerging and returning tracks in single file upto a distance of about 14 m from water, after which there were numerous zigzag tracks. A track leading up and down the slope between 'X' and the temple was also marked. No track could be seeen between the temple and the enclosure. The ground in this area was hard and thus it was not possible to know if at all the mugger had moved through this region.

Subsequent to this observation the mugger

was never again sighted near GRACU. GRACU is about 17.2* km up the foot of the gorge. Later sightings were at 15.0 Km (22.2.78), 9.0* Km (24.2.78), 6.4 Km (24.3.78) and 11.2 Km (19.4.78). During February to April, 1978 the water level was +5.0 to –12.0 cm in relation to the datum.

Discussion

Dharmakumarsinhji (1947) observed mating in *C. palustris* on the 19th March. But David (1970) records mating in captivity in December-January and nesting in March-April. Acharjyo & Mishra (1976) observed in a captive *C. palustris* on 11.6.74 but later discovered the eggs to be infertile. Whitaker & Whitaker (1976) observe that *C. palustris* mates between January and March and the eggs are laid after about two months of mating.

In the foregoing account the behaviour of the wild mugger, 2.8 m in size, toward male captives, 1.8 m in size, was recorded at GRACU during December to mid-February. Constant showing up of the wild mugger, believed to be a female, near the shore down the mugger enclosure of GRACU, and her movement to close quarters of the enclosure suggest that she was attempting to reach the male muggers in captivity. The last attempt was made on the night of 15.2.78. Probably during this attempt she became sure that it was not possible to reach the male captives. This behaviour of the wild mugger toward the male captives suggest that she was trying to fulfil her mating urge. The period during which these observations were made correspond to the mating season of the mugger, reported earlier.

Interestingly, the wild mugger did not attempt to approach any of the other five enclosures having gharials and muggers of comparable age. One of the enclosures had seven female muggers and a male mugger of similar age but measuring only 72.0 cm to 139.4 cm and weighing 1.7 kg to 11.6 kg on 4.2.78. The washings of this enclosure also enter the river but at about 200 metres upstream from the point where the washings from the "Mugger enclosure" enter the river. This suggests that the wild mugger knew that the "Mugger enclosure" was housing sexually mature males. This inference draws up another conclusion on the record growth of captive muggers at GRACU. The muggers at GRACU under discussion were only two years and ten months old in February 1978 but had reached a length of 1.3 m to 1.8 m. The five muggers housed in the Mugger enclosure had grown fast among all-total thirteen muggers reared in captivity at GRACU.

Probably the cue which might have directed the wild mugger to know the location of the captive males were the washings from the enclosure entering the river, and the night time activities of the males, which include fights with loud sounds. It is interesting to note that the mugger was never sighted upstream of the point where the washings of the Mugger enclosure enter the river.

Acknowledgements

The researcher receives a research fellowship from the Government of Orissa (Forest Department) through the Crocodile Project. He is indebted to the staff at GRACU who helped in collection of the data for this paper.

LALA A. K. SINGH

Gharial Research and
Conservation Unit,
Tikerpada-759122, Orissa,
June 22, 1978.

REFERENCES

ACHARJYO, L. N. AND MISRA, R. (1976): Egg laying of the mugger (*Crocodylus palustris*) in captivity. *J. Bombay nat. Hist. Soc.*, *73*(1): 22.

DAVID, R. (1970): Breeding the Mugger Crocodile and Water Monitor — *Crocodylus palustris* and *Varanus salvator* at Ahmedabad Zoo. *International Zoo Yearbook*, *10*: 116-117.

DHARMAKUMARSINHJI, K. S. (1947): Mating and the parental instinct of the Marsh Crocodile (*Crocodylus palustris* Lesson). *J. Bombay nat. Hist. Soc.*, *47*(1): 174-176.

WHITAKER, R. AND WHITAKER, Z. (1976): Collection and hatching of Marsh crocodile (*C. palustris*) eggs. *J. Bombay nat. Hist. Soc.*, *73*(2): 403-407.

14. WINTER TEMPERATURE GRADIENT IN TUNNELS OF *UROMASTYX HARDWICKII* GRAY

During winter reptiles are said to hibernate and normal activity is thought to be absent. Hence it had been presumed that they have no predatory role to play. However, recent studies on burrow temperatures in two marked colonies in Delhi region have revealed an altogether different picture that indicates only partial hibernation in *Uromastyx hardwickii* species during winter as is evident from open burrow mouths and burrow temperatures. Tunnel temperature is near to "activity temperature" and ranges from 20.5°C to 25.5°C in plugged burrows. Whereas, in open burrows it ranges from 21.5°C to 22.5°C during mid day at depths ranging 10 to 25 cm within the tunnel and at surface temperature of 20°C to 23°C in dry bulb. This tunnel temperature is somewhat close to their "activity temperature" recorded in summer season from about 28°C onwards to 35°C above which onset of panting occurs (Bhatnagar *et al.* 1973 & *in press*). Tunnel temperature at neck region appears to be independent of the 'tunnel slope' & depths varying before the point tunnel bend commences, normally ranges from 35-140 cm in Delhi region and as temperature ranges were nearly same. Variation in thickness of "clay plug" at burrow mouths ranged from 2.5 to 11.5 cm, yet, temperature fluctuation was not significantly different. Out of 39 burrows, 10 were found open and 29 were plugged and there is not much difference in temperature. It perhaps indicates that there is no total hibernation in the individuals as is also evident from, the marks on the soil indicating locomotory activity of the lizard and by presence of undigested food in gut of lizards. Individuals on attaining the 'activity temperature' after basking resume daily activity around mid day. In one burrow, presence of ants emerging out of burrow perhaps indicate death of the lizard in the burrow at this temperature. Presence of smaller 'clay plug' also indicates resumption of activity on attaining of required temperature. It may be mentioned here that this tunnel temperature during winter is not much lower than what it ranges during summer, i.e. at surface temperature of 28° - 35°C, it ranges upto 26.2°C at depth of 12 cm from mouth. It further indicates that burrow making is a thermoregulatory adaptation in which temperature is well maintained and activity depends upon burrow temperature rather than on surface temperature.

DIVISION OF ENTOMOLOGY,
INDIAN AGRICULTURAL
RESEARCH INSTITUTE,
NEW DELHI-110 012,
June 24, 1976.

R. K. BHATNAGAR
R. K. BHANOTAR
Y. MAHTO
Y. N. SRIVASTAVA

REFERENCES

BHATNAGAR, R. K., BHANOTAR, R. K., & SRIVASTAVA, Y. N. (1973): Panting behaviour of *Uromastyx hardwickii* Gray. *Entomologist's Newsletter,* Delhi, 3(7): 46-47.

BHATNAGAR, R. K., BHANOTAR, R. K. & MAHTO, Y. (*in press*): Saurian winter activity in Thar Desert. *Proc. Zool. Bengal;* mss. pp. 1-10, 3 tables.

15. IDENTIFICATION OF SNAKE SKINS

(*With two plates*)

Madras and Calcutta are the two major centres where snake skins are tanned and exported. It may be interesting to note that from Madras a total number of 7,83,100 pieces of snake skins, valued at Rs. 1,35,99,320 have been exported between 1.1.76 and 31.12.76. Similarly during 1977, a total number of 6,38,750 pieces valued at Rs. 90,26,941 have been exported. For Calcutta the figures are as follows: during 1976 a record number of 15,23,626 skins valued at Rs. 68,89,565 and for 1977, about 10,99,192 skins valued at Rs. 1,01,97,391 have been exported. Mostly these skins are purchased by West Germany, U.K., Italy and France. It is also worthwhile to note that it is mainly skins of the Rat snake or Dhaman (*Ptyas mucosus*), that is being exported, while export of others like that of Cobra, Python, Russel's viper is almost negligible.

Identification of snakes, usually is done by the study of scales in the belly, the head and the back — whether it is scaly and uniform throughout or whether ventral shields extend the whole width or not and so on. All these processes are no doubt the best conclusive proof to know whether a snake is poisonous or otherwise. Unfortunately in identification of tanned skins meant for export, it is usually not possible to make use of these characteristics. It is for this simple reason that one cannot know whether the ventral plates extend the whole width of the belly or not. Also very rarely can one see all scales and shields on the head intact and in proper position.

The common snake skins that were being exported on a large scale belong to the following species:

1) Rat Snake or Dhaman.
2) The Indian Python.
3) The Common Cobra.
4) Russell's Viper.

Skins of the above snakes can be identified by the following characteristics:

Rat Snake:— Rat snake's skins are erroneously called "Whip-snake skins" by the trade. The real whip snake, however, is the common green whip snake (*Ahaetulla nasutus*), so called because of its very long, thin, whip-like body.

Rat snakes grow to a length of about 240 cm or even more and have a girth of about

10 cm. The tail is about one-fourth of the total length of the snake and the tail shields are divided. Skins of this snake are keenly sought after for their length. A portion of the skin has the following features that will help in identification:

1) There is a central band of scales consisting of three rows of costals which are distinctly different from the rest in that they are almost squarish.

2) On either side of this central band are seven rows of costals which are of different shapes in the top half, but lower down they are all alike and squarish. Thus all put together there are 17 rows of scales except near the tail where it may be one or two less.

3) The last row of costals bordering ventrals are slightly larger than all other scales.

4) Almost all the scales have black borders and appear in the form of irregular rings in the lower half of the body as well as tail.

5) On either end is one half of ventrals which are about 2 cm long and 7-8 mm wide. In a complete snake skin there is only one row of ventrals extending the whole width of the belly, but then it is slit down the middle of the belly at the time of skinning, so that in a tanned skin, it appears as if there are two rows of large scales one at either end.

6) The central band of scales are almost closely packed that they look like touching each other. In the flanks the scales are independent with lot of interspaces between one another.

Indian Python:— With a full length tanned skin, this is one of the easiest to identify by its length and width that are unsurpassed by any other Indian snake. A portion of the skin has the following features:

1) The scales are all quite small and are almost rectangular in shape except those at the flanks.

2) The scales are smallest at the centre, gradually becoming bigger towards the flanks.

3) The last row of scales that represents one half of the ventrals are the largest.

4) The last 8-10 rows almost overlap each other on the flanks.

5) Compared to the Rat snake, the ventrals are proportionately small in relation to the size of the skin. This is due to the fact that the ventrals do not cover the entire width of the belly.

6) In all there are about 70 rows of scales.

Common Cobra:— Apart from the Python, the common Cobra is the easiest to identify whether dead or alive, of course if available with its monocled or spectacled hood. However, even without it, the following features will help identify a Cobra skin with ease:

1) There is a central row of narrow dorsals which are pearshaped and looks almost beaded running over the entire length from head to tail.

2) On either side of this mid dorsal row, there are usually 11 rows of dorsals arranged in an expanded 'V' shape.

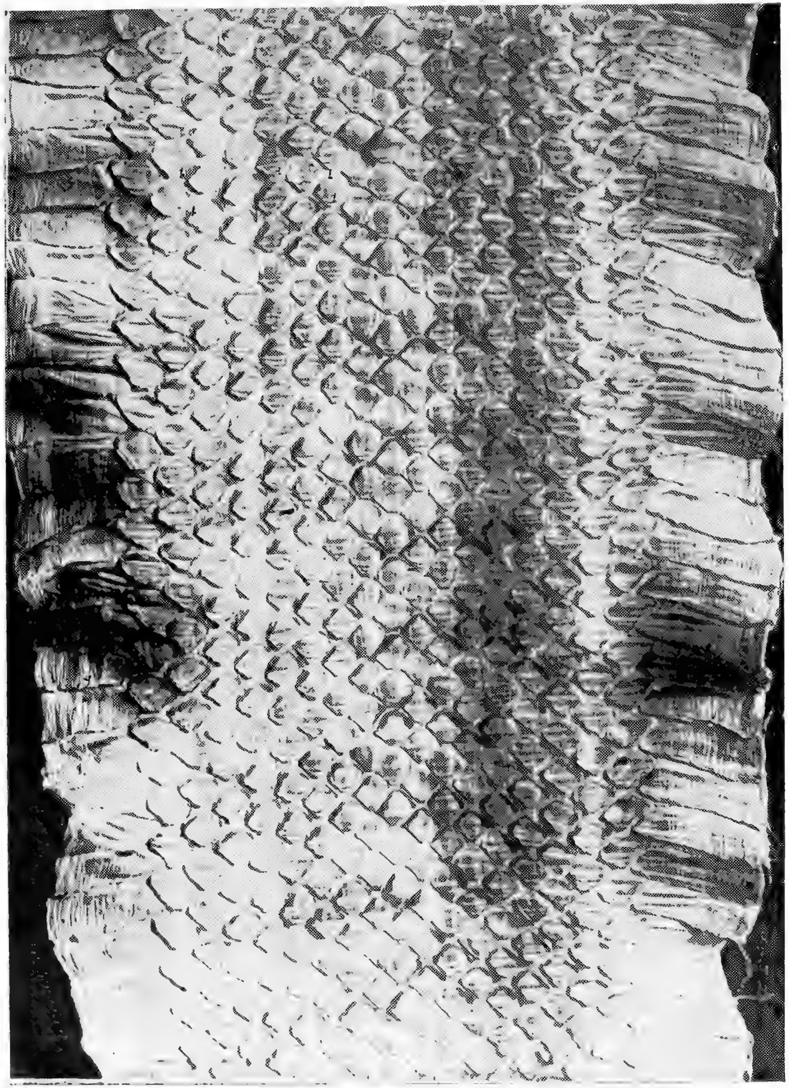
3) All the scales are absolutely independent with lot of interspaces and rarely touch each other.

4) The last row of longitudinal scales are the real ventrals. Each ventral is two to two and a half centimetres long in a tanned skin.

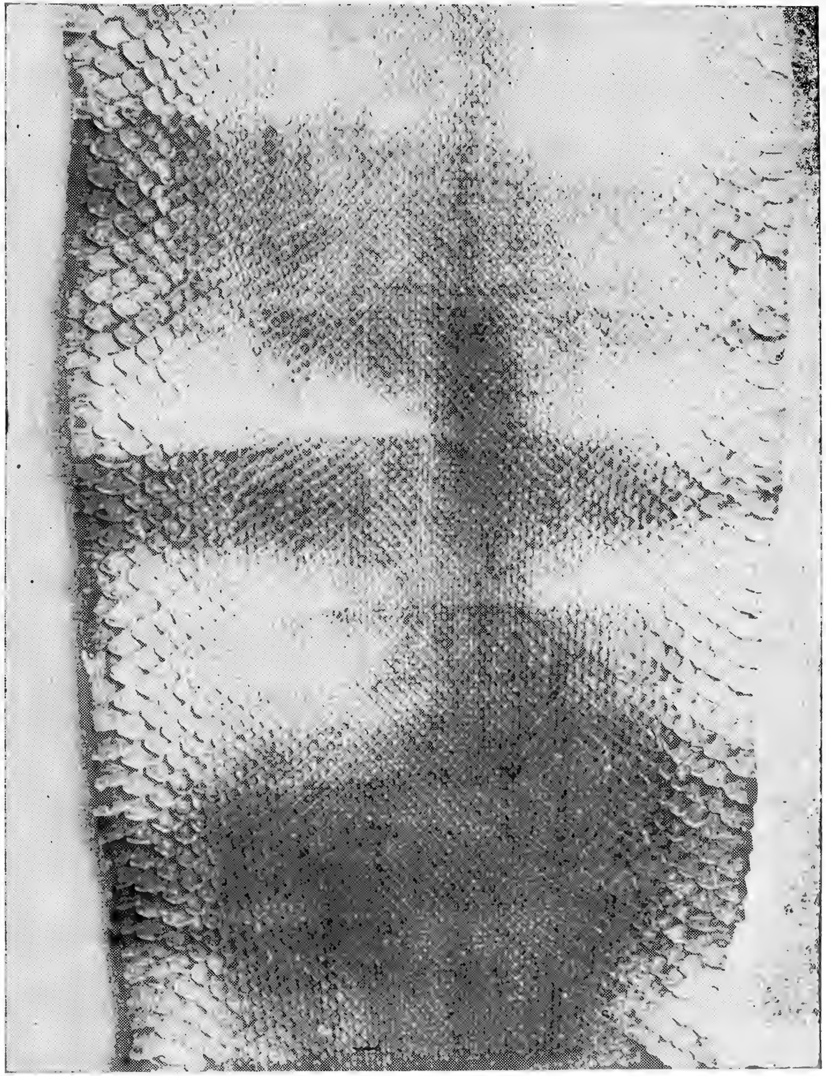
Russell's Viper:—This is the commonest pitless viper of India and is a large snake growing to nearly 165 cm. in length but is more stoutly built than other vipers. It is a very handsome snake whose skin has the following distinctive characteristics:

1) There are three large more or less circular black bands arranged in three rows running over the entire length of the skin.

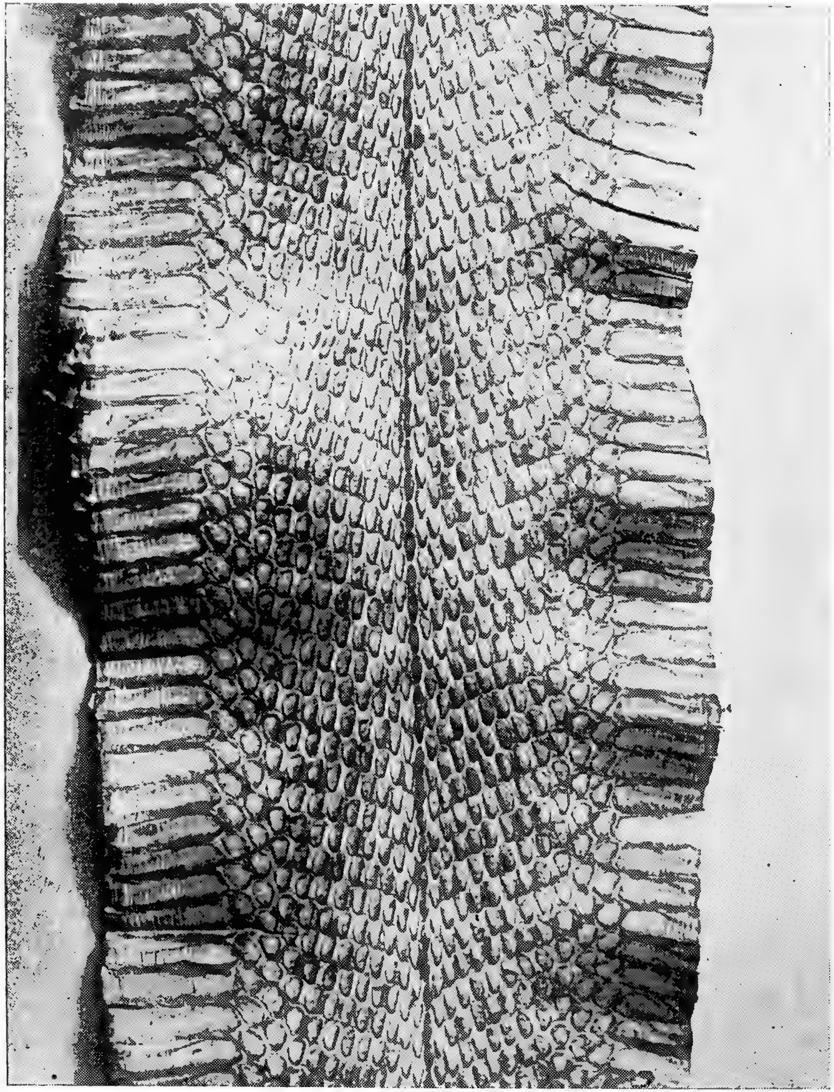
2) The middle row is more conspicuous than the others.



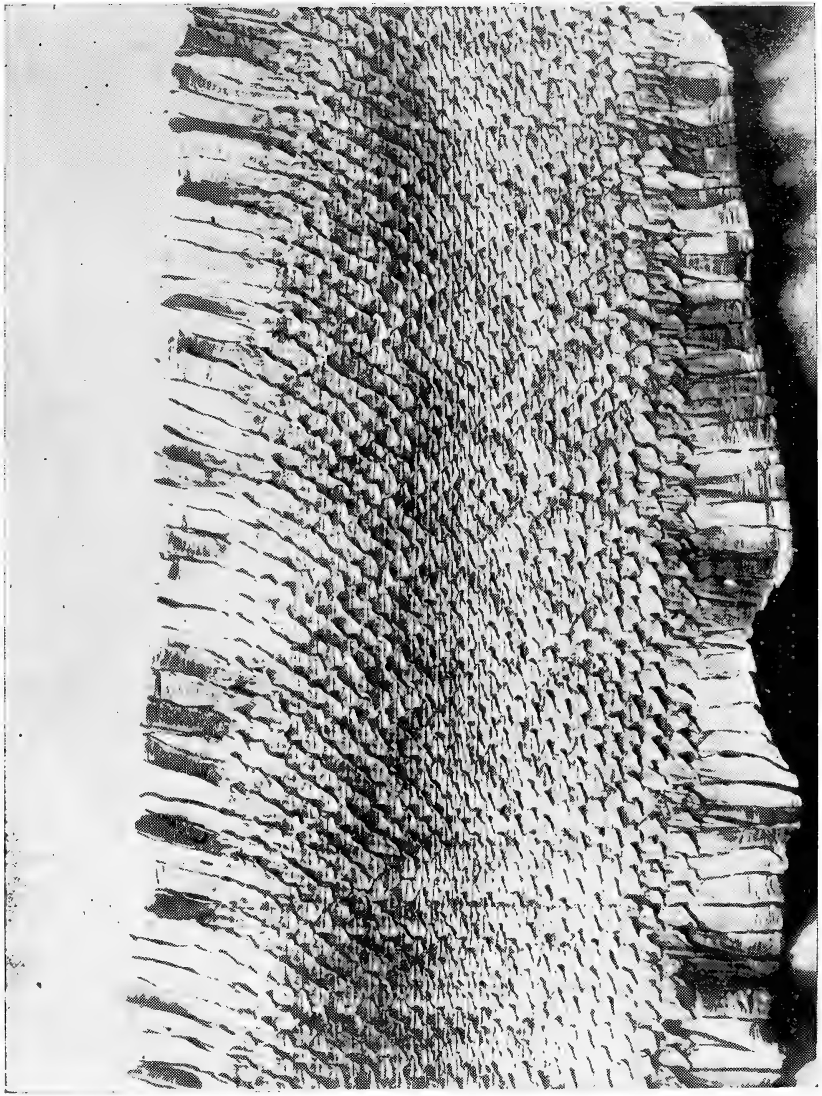
A portion of Rat snake's skin.



A portion of Python's skin.



A portion of Cobra's skin.



A portion of Russell's Viper's skin.

3) The scales are all more or less uniform, except the rows bordering the ventrals which are slightly larger in size. They are prominently leaflike in appearance with a clear keel, which becomes less and less conspicuous towards the flanks till it is almost absent in the last rows bordering the ventrals.

4) The scales are so closely arranged that they are almost overlapping one another, with no interspaces between them.

5) The ventral plates are very large and forms almost one-third to half the width of the skin.

K. VISWANATHAN

Assistant Director,
Wildlife Regional Office,
Madras 600 020,
May 2, 1978.

16. FOOD OF *RANA HEXADACTYLA* LESSON

A fair amount of literature is available on the diet of the Indian Bull Frog, *Rana tigerina* (Mullan 1912; Ishwar Prakash 1953; Wadekar 1963; Joshee 1968; Isaac and Rege 1975) but little is known about the food of *Rana hexadactyla*. The present study was undertaken with the object of determining the food of *Rana hexadactyla* by the examination of the stomach contents.

Materials and Methods

The frogs were collected between February and September of 1975 from paddy fields, rivers and ponds. They were captured at night, killed immediately and preserved in 10 per cent formalin. In the laboratory, the frogs were weighed, sexed and dissected out to collect the stomach contents. The weight of stomach contents of each frog was recorded and the different food items from individual stomachs were identified. Out of the 319 frogs dissected for stomach contents 203 were females and 116 males. Frogs with their stomach contents weighed between 25 gm and 100 gm.

Results and Discussion

Table 1, which gives the different food items of *Rana hexadactyla*, indicates that insects form the main diet. From the observations recorded in the present study it can be noticed that insects, crabs, snails, small fishes and young frogs are the major food items. Arthropods form the bulk of the diet of *R. hexadactyla*. Amongst the arthropods insects appear to be most favoured food of this frog. Some of these insects are of great economic importance. A few centipedes and millipedes and quite a number of arachnids were also recorded from the stomachs of this animal.

Crabs were found in large numbers in the diet of *R. hexadactyla*. They are often seen in the paddy fields and cause damage to the bunds in the fields by boring holes in them. Crabs are recorded as one of the major pests of paddy (Kadam *et al.* 1960) and are known at some stages of their life to feed on rice seedlings both before and after transplanting. The frog is thus very helpful in keeping the population of crabs harmful to agriculture in

TABLE 1

ANALYSIS OF THE STOMACH CONTENTS OF *Rana hexadactyla* LESSON

Classified food items	Number of individual food items collected	Number of stomachs from which collected	Remarks
Phyllum ARTHROPODA			
Class INSECTA			
Order ODONATA			
Dragonfly	5	5	broken into pieces
Nymph of Dragon fly	1	1	predaceous in habit.
Order DERMAPTERA			
Family Labiduridae			
Labidura riparia	3	3	carnivorous, eats small insects.
Order ORTHOPTERA			
Family Gryllotalpidae			
Gryllotalpa fosser	6	6	pest on paddy.
Family Gryllidae			
Gymnogryllus sp.	1	1	
Gryllus sp.	1	1	omnivorous.
Family Acrididae			
Spathosternum calignosum W.	1	1	
Hieroglyphus banian	3	3	very harmful to paddy.
Order HEMIPTERA			
Family Belostomatidae			
Sphaerodema rusticum	11	11	carnivorous water bugs.
FAMILY Gerridae			
Gerris sp.	23	1	water skaters.
Order LEPIDOPTERA			
Caterpillar	49	32	great economic importance.*
Order DIPTERA			
Family Culicidae			
Anopheles sp.	1	1	transmits malaria.*
Family Chironomidae			
Chironomus larva	2	1	
Family Muscidae			
Musca sp.	1	1	household pest.
Order HYMENOPTERA			
Family Formicidae			
Diacamma vagans Smith	7	7	
Odontomachus sp.	5	5	
Order COLEOPTERA			
Family Carabidae			
Bembidion soborium ..	8	3	highly predaceous.
Chlaenius sp.	7	4	
Dioryche sp.	2	2	

Family Scarabaeidae			
Anomala dussumieri	4	1	larva forms damage roots of paddy & cereals.
Autoserica insanabilis Brenske	7	2	
Anserica sp.	4	2	
Mimela sp.	2	1	
Family Hydrophilidae			
Sternolophus brachyacanthus Reg.	12	5	
Hydrophilid sp.	1	1	larvae predaceous.
Family Elateridae			
Melanotus hirticornis	4	3	
Family Tenebrionidae			
Gonocephalum sp.	2	1	
Family Curculionidae			
Odioporus sp.	1	1	
Class CRUSTACEA			
Paratelphusa (*Oziotelphusa*) *bouvieri* Rathteum	13	10	common in paddy fields and pest of crops; some in semi-digested condition.
Class ARACHNIDA			
Order ARANIDA			
Family Lycosidae			
Pardosa songosa Tikader & Malhotra	1	1	
Pardosa burasantiensis Tikader & Malhotra	1	1	
Lycosa sumatrana Thorell	2	2	
Lycosa bistriata (Gravely)	1	1	
Family Araneida			
Araneus sp.	5	2	
Family Heteropodidae			
Heteropoda sp.	1	1	
Family Tetragnathidae			
Tetragnatha mandibulata	1	1	
Class MYRIAPODA			
Order SCOLOPENDROMORPHA			
Family Scolopendridae			
Otostigmus sp.	3	3	
Millipede	2	1	broken into pieces.
Phyllum MOLLUSCA			
Class GASTROPODA			
Order BASOMMATOPHORA			
Family Planorbidae			
Indoplanorbis exustus (Deshayes)	10	2	Shells in undigested condition.
Order SYSTELLOMMATOPHORA			
Family Veronicellidae			
Laevicaulis sp.	1	1	

Class PISCES			
Order CYPRINOIDEA			
Family Cyprinidae			
Puntius sophore (Ham.)	10	6	few semidigested.
Family Naudidae			
Badis badis (Ham.)	6	2	semidigested.
Anabas scondens	1	1	semidigested.
Class AMPHIBIA			
Order ANURA			
Family Ranidae			
Rana sp.	5	5	young frogs and semidigested; in few cases bones only.
Class REPTILIA			
Order OPHIDIA			
Family Typhlopidae			
Typhlop sp.	2	2	broken into pieces.
Snake	2	2	only tail and skin.

check. Some gastropods were recorded from the stomachs of a few specimens. The vertebrate groups such as Pisces, Amphibia and Reptilia were also represented in the food of this frog, but there is no reason to believe that they form regular items of the diet.

Vegetable matter in the form of leaves, grass blades, algae, etc. and gravel were seen in the stomachs of a number of frogs. It seems more likely that the vegetable matter as also the gravel is taken up by the animal accidentally along with food. The occurrence of gravel in the stomachs of frogs is reported by many workers.

Mondal (1970) observed that the "Northern race" of *R. hexadactyla* is phytophagous while in the "Southern race" the animal food was preferred and preponderates over vegetable matter. The present study indicates that *R. hexadactyla* in this area of Kerala is largely carnivorous, feeding on animal food only. It is possible that the vegetable material found in the stomachs of a number of frogs was taken in accidentally along with other food.

The examination of the intestine of tadpoles of *R. hexadactyla* shows that the vegetable matter forms their main food. The highly coiled and elongated nature of the alimentary canal indicated their herbivorous food habit. Food of juvenile frogs consists largely of insects (Jameson and Rose 1956) and that of tadpoles mainly the different species of algae (Kamat 1962).

The present observations indicate that *R. hexadactyla* feeds on some important agricultural pests, especially paddy pests. Thus this species of frog plays a significant role in the economy of nature by controlling agricultural pests in the field.

ACKNOWLEDGEMENTS

The author expresses his sincere thanks to The Charles McCann Field Work Fund of the Bombay Natural History Society for financial assistance. Thanks are due to Mr. Humayun Abdulali for encouragement and valuable suggestions and also to Bombay Natural History Society, Bombay, the Forest Research Institute, Dehra Dun and the Zoological Survey of India, Calcutta for the identification of insects and other specimens.

MAR THOMA COLLEGE,
TIRUVALLA-689 103,
KERALA,
April 28, 1978.

M. I. ANDREWS

REFERENCES

ISAAC, S. AND REGE, M. S. (1975): Food of *Rana tigerina* (Daud.) *J. Bombay nat. Hist. Soc. 72* (1): 143-157.

JAMESON, D. L. AND ROSE, M. M. (1956): Food habits in juvenile frogs. *Copeia* 1956 (4): 261.

JOSHEE, A. K. (1968): Food habits of the Bull Frog (*Rana tigerina* Daud.). *J. Bombay nat. Hist. Soc., 65* (2): 498-500.

KADAM, M. V. BHAT AND PATEL, G. A. (1960): 'Crop pests and how to fight them.' Dir. Pub. Govt. of Maharashtra, Bombay.

KAMAT, N. D. (1962): On the intestinal contents of tadpoles and algae of small ponds. *Curr. Sci., 31*: 300-301.

MONDAL, A. K. (1970): On the distribution, occurrence, culture possibilities and food of *Rana hexadactyla* Lesson. *Scie. and Cult., 36*: 138-143.

MULLAN, J. P. (1912): The food of a Bull-frog (*Rana tigerina*). *J. Bombay nat. Hist. Soc. 21* (4): 1341.

PRAKASH, ISHWAR (1953): Addition to recorded food items of the Bull Frog (*Rana tigerina*). *J. Bombay nat. Hist. Soc. 51* (3): 750.

WADEKAR, U. L. (1963): The diet of the Indian Bull-frog (*Rana tigerina* Daud.). *J. Bombay nat. Hist. Soc., 60* (1) 263-268.

17. ON THE BREEDING BEHAVIOUR OF *SCHIZOTHORAX NIGER* HACKEL IN DAL LAKE[1]

(*With a text-figure and a photograph*)

INTRODUCTION

The fishes of sub-family schizothoracinae of Dal lake are known to perform spawning migration and lay eggs on the bottom of snowfed streams (Rampal 1967; Jan and Dass 1971; Sunder *et al.* 1977 and CIFRI Bull. 1977) that empty into the lake. During spring of 1977 spawning grounds of *Schizothorax niger* were located for the first time in the Dal lake itself, differing thus in breeding habits from other members of the sub-family. The eggs were located in the shallower regions of the lake around Bhatmazar (behind Engineering College), Gurtupora, Lathkadal on the south-east of lake and Sonalank in the Harzatbal-Saidakadal region (Fig. 1). Eggs were also collected in the shallow areas of Pishpow nallah (Shalimar region) on the north-west of the lake. In Harzatbal-Saidakadal region the eggs were found attached to the submerged adventitious roots of willow (*Salix* spp) trees, while in the Shalimar region they were found scattered in clutches along the lake bed close to springs. The fertilized eggs ranged in diameter between 2.6-3.5 mm. The physico-chemical characteristics of the Harzatbal-Saidakadal and Shalimar-Thaksar regions of the lake are given below in Table 1.

The percentage of fertilization as determined by acetic acid method ranged between 75 to 84. Quantitative assessment of eggs attached to willow roots could not be made while number of eggs laid on lake bed ranged from 400 to 460 m², only 50 per cent of eggs were found viable. The spawning period was ob-

TABLE 1

SOME RELEVANT PHYSICO-CHEMICAL CHARACTERISTICS OF DAL LAKE

Parameter	Hazratbal-Saidakadal region	Shalimar-Thaksar region
Water depth	20-35 cm	26-36 cm
Water temperature	17-20°C	15.5-17°C
Turbidity	13-16 cm	nil
pH	7.2-7.3	6.6-6.8
Dissolved oxygen	9.2-9.6 ppm	9.8-12.6 ppm
Free carbon dioxide	1.2-1.8 ppm	6.8-10.4 ppm
Total alkalinity	86-95 ppm	26-58 ppm

seved to last for about two months from 1st week of March to end of April.

To find out the incubation period, the eggs collected from the lake were transported to laboratory and kept in enamel trays under various treatments. The results of experiments are given below in Table 2.

prominant nuptial tubercles on the snout and coupled with it the roughness of body in males. The roughness of body and tubercles become evident just before spawning season starts and disappears shortly after spawning.

On March 20, 1977 an attempt was made to strip artificially *S. niger* collected from the lake. The eggs were stripped into enamel trays and the milt from male mixed. This operation was done at the lake site and the fertilized eggs transported to laboratory for rearing purposes (Photo. 1). The brood fish were in 260-310 g in weight range and 310-409 mm in length range. Number of eggs per kg of body weight were in the range of 15,100-17,200 The fertilization in artificially stripped eggs was 95%. These eggs were kept in enamel trays for rearing under three different sets of experiments and the results are given below in Table 3. The early fry were produced within 10-15 days.

TABLE 2

RESULTS OF EXPERIMENTS ON INCUBATION PERIOD OF EGGS COLLECTED FROM NATURE

Treatment	Temperature (°C)	No. of eggs/set	No. of hatchlings	No. of days taken for hatching	Percentage survival
a) *Still water*					
i. only water	13-17	50	21	5-13	42
ii. with sand & pebbles	13-17	50	22	5-13	44
iii. with lake mud	13-17	50	12	4-15	24
b) *Flowing water*					
	9.8-11.5	50	2	18-22	4

During the breeding season, the sexes can be easily distinguished by the soft, enlarged and distended belly in the females and presence of

[1] The Abstract of the paper was presented at the 65th Session of Indian Science Congress held at Ahmedabad, January 1978.

RESULTS AND CONCLUSIONS

For the first time spawning grounds of *Schizothorax niger* have been located in the lake itself. The study reveals that immediately after winter when the lake temperature touches 14-18°C, *S. niger* breeds in certain pockets of the lake. The absence of spawning

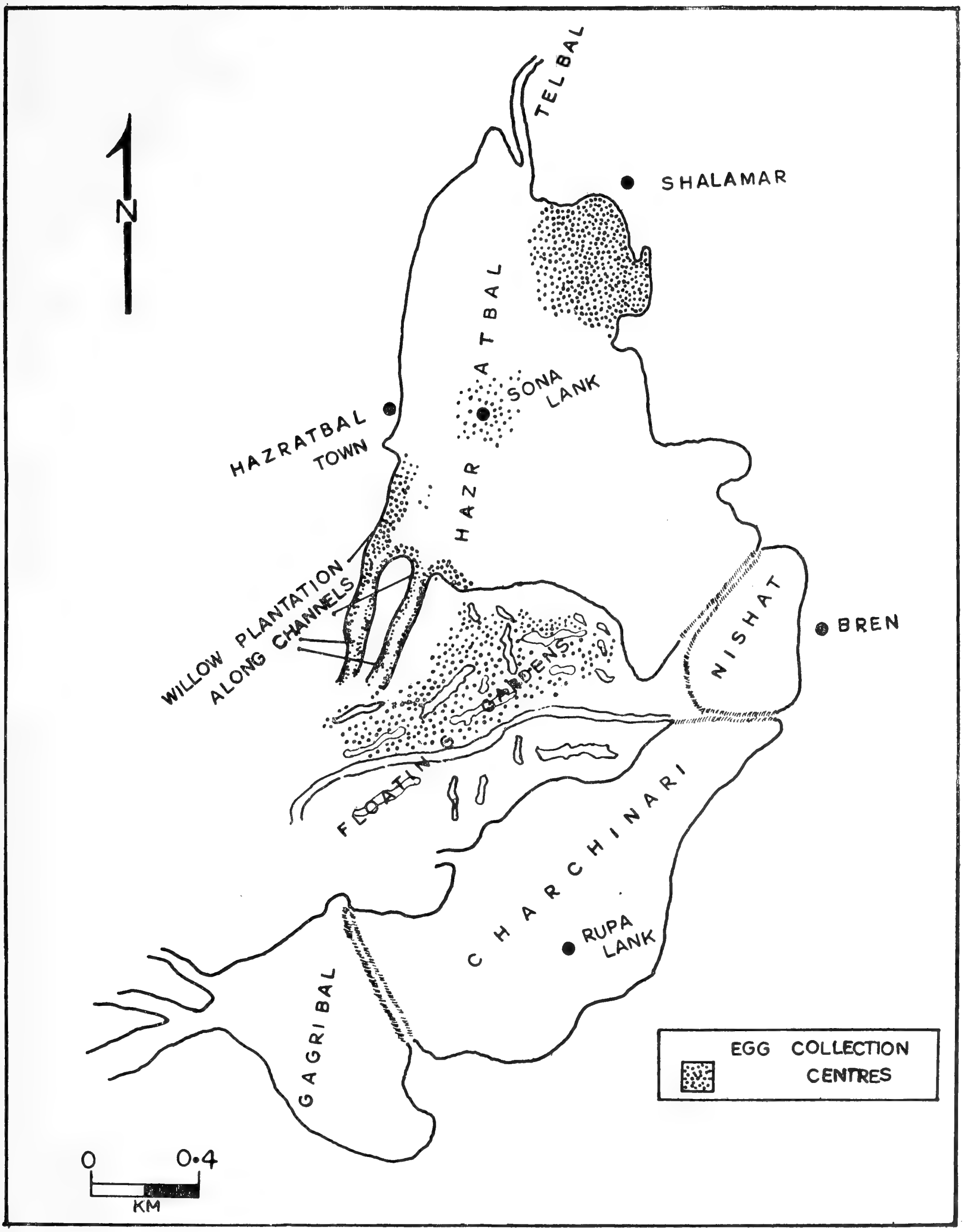


Fig. 1. Egg collection centres in the Dal Lake.

TABLE 3

RESULTS OF REARING EXPERIMENTS OF ARTIFICIALLY STRIPPED EGGS UNDER DIFFERENT TREATMENTS

Treatment	Temperature (°C)	No. of eggs/set	Hatching days from eggs to larvae	Absorption of yolk sac in days	Percentage survival	Total no. of days
a) *Still water*						
i. inside Lab.	13-16	250	7-9	5-7	85.5	14
ii. outside Lab.	13-23	250	4-5	5-6	85.5	10
b) *Flowing water*						
i. Outside Lab.	9-11	100	29-35	6-11	20	40

TABLE 4

THE SALIENT CHARACTERISTICS OF THE EGGS COLLECTED FROM THE LAKE AND THOSE ARTIFICIALLY STRIPPED. BOTH REARED UNDER LABORATORY CONDITIONS

Eggs stripped from *S. niger* and reared in Laboratory	Eggs of *S. niger* collected from Dal lake and reared in Laboratory
a. Eggs	
Fertilized eggs are spherical, translucent, demersal adhesive. They are creamy-yellow in colour. Eggs swell within fifteen minutes after extrusion and fertilization. Size ranges between 2.5-3.5 mm. The egg membrane is tough and smooth on the outside. The perivitel-line space between the vitelline membrane and yolk is absent.	Fertilized eggs are spherical, translucent, demersal adhesive and creamy yellow in colour. Size ranges between 2.5-3.6 mm. The egg membrane is smooth and tough. The perivitelline space is absent. tough. The perivitelline space is absent.
b. Newly hatched larvae	
The yolk sac of the newly hatched larvae is half of the body length. The mouth is not apparent. It possesses a continuous fin-fold along the dorsal edge running behind the head to around the tail. Size of larva ranged between 7.0-8.0 mm. Melanophores are present on the body. Normally for the first 10-15 minutes after hatching the larvae just flick their tail along the bottom of tray. They progressively get more powerful and start to swim off, swimming upwards. When swimming ceases they become motionless and turn upside down with the head pointing downwards and steadily sink to bottom.	The larvae is 7.2-8.0 mm in size. Yolk sac is half the length of the body. It is devoid of mouth. The larval fin-fold is continuous and around the caudal end. Melanophores are present. It swims like the larvae produced from artificially stripped eggs.
c. Fry	
The yolk diminishes completely. The size of swim-up fry range between 9-10 mm.: Mouth is well developed. More melanophores have appeared along the ventral and dorsal surface. But more numerous on the head region of the body. The pectoral and caudal fins are well developed. The fry of 15-16 mm size has well formed body of fins.	The yolk is completely absorbed. The size of swim-up fry ranges between 9-10 mm. Pectoral and caudal fins are well developed. Mouth is developed with distinct alimentary canal. Melanophores are present and abundant on the head region of the fry. The fry of 15-16 mm size has well developed body and morphologically similar to the fry produced from artificially stripped eggs.

beds in the Gagribal and Charchinari area of the lake may be ascribed to topographic unsuitability especially lack of sheltered shallow areas. If lake water attains optimum temperature early due to favourable meterological conditions the fish may breed early (as in the year 1977 when fish started breeding in first week of March); otherwise the breeding may be delayed by a month or so. The water chemistry of the spawning grounds does not give any clear indication that the fish prefers any special chemical spectrum to breed. The water chemistry of these grounds is similar to the other parts of the lake.

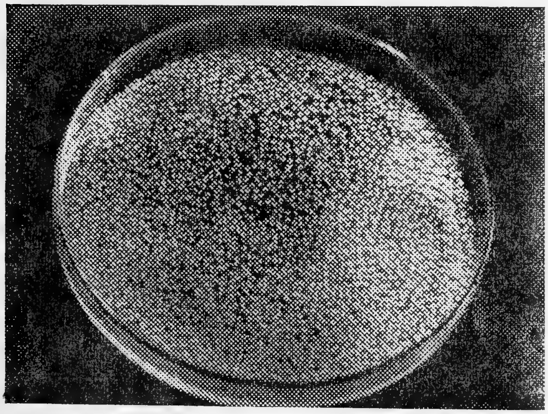


Photo 1. Artificially fertilised eggs of *Schizothorax niger.*

To confirm the species, apart from experimental fishing in and around the spawning grounds, the eggs collected from nature and those artificially stipped were reared under laboratory conditions and the developmental stages noted (Table 4). Similar developmental features were observed in both the sets.

The hatching experiments with eggs collected from nature clearly indicate that the survival was more (42 and 44%) if the eggs are kept in still water with or without sand and pebbles, it was 24% in mud and only 4% in flowing water conditions (Table 2). The most encouraging aspect of the species is that it can easily be stripped. It takes about 14 days from egg to early fry stage at 13-16°C, with increase in temperature (13-23°C) the incubation period was lowered to 10 days (Table 3). In flowing water, the incubation period was observed to be very long, more than 40 days. Survival rate in case of artificially stripped under flowing water was also low (less than 20%) compared to 85% in still water (Table 3). This feature indirectly indicates that lentic water is more suited for breeding and early development. The preference of fish for lake breeding under the circumstances is self evident. These experiments give adequate indication that for *S. niger* running water is not essential for breeding and early development.

The present observations showing that the spawning habitat of *S. niger* lies within the Dal lake, constitutes an important finding and has immediate relevance in the revival of the declining fishery. The present investigation provides adequate basis for management measures like closed season and closed areas. The studies further indicate that the fish is amenable for artificial propagation as reflected by successful stripping and rearing experiments. This advantage can be utilized for raising stocking material to strengthen both the lake stock as well as for culture purposes.

Acknowledgements

We are indebted to Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute, Barrackpore for his interest in the work. We are grateful to Dr. A. V. Natarajan, Head, Riverine and Lacustrine Division for critically going through the manuscript and suggesting improvements.

COLD WATER FISHERIES
RESEARCH UNIT, C.I.F.R.I.,
HARWAN,
KASHMIR,
December 8, 1978.

K. K. VASS
H. S. RAINA
SHYAM SUNDER

REFERENCES

ANONYMOUS (1977): Report on Dal lake, Srinagar, Kashmir with suggestions for development of its fisheries. *Bull. Centr. Inl. Fish. Inst.* (24) 13 pp. (Mimeo).

JAN, N. A. AND DAS, S. M. (1971): Studies on the food and seasonal variation in fisheries of Kashmir valley. *Kash. Sci. 8* (1 & 2): 102-110.

RAMPAL, CHENDER (1967): Studies on the early life history of five Kashmir fishes together with the fecundity and breeding habits. Ph.D. Thesis. Jammu and Kashmir University, 150 p.

SUNDER, SHYAM, BHAGAT, M. J., JOSHI, C. B. AND RAMAKRISHNA, K. V. (1977): Some aspects on the fishery and biology of *Schizothorax niger* Hackel from Dal lake, Kashmir (MS).

18. A NOTE ON THE ZOOGEOGRAPHY OF INDIAN MELOIDAE (COLEOPTERA)

The information regarding the Meloidae (Coleoptera: Heteromera) of India though at the moment is incomplete in many ways, the available data does show considerable evidence on the Zoogeographical affinities of the blister beetles.

Blister beetles are represented at present by 105 species belonging to 19 genera. Table 1 shows that the meloids exhibit a high degree of endemism. About 66.6 per cent species are

TABLE 1

ZOOGEOGRAPHICAL ANALYSIS OF MELOIDAE FROM INDIA

Sub-families and tribes	Total genera	number species	Endemic species	Oriental species	Palaearctic species	Ethiopian species	Australian species	Nearctic and Neotropical species	Wide spread species
Meloinae									
Eleticini	1	4	2	1	—	1	—	—	—
Epicautini	3	34	24	10	2	—	—	—	—
Mylabrini	3	21	11	7	3	2	—	—	—
Lyttini	5	25	17	7	1	—	—	—	—
Meloini	1	4	2	—	2	—	—	—	—
Zonitinae									
Zonitini	4	14	14	—	—	—	—	—	—
Horiinae									
Horiini	1	2	—	2	—	—	—	—	—
Cissitini	1	1	—	1	—	—	—	—	—
Total	19	105	70 66.66%	28 26.66%	8 7.61	3 2.85%	—	—	—

endemic to India. The tribe Zonitini is entirely endemic.

As should be expected, a high percentage *c.* 27 per cent constitute the Oriental element. In Palaearctic realm, about 8 per cent of the species have so far been recorded. The Ethiopian element is rather very poorly represented and constitute about 3 per cent of the total fauna. It is interesting to note the complete absence of Nearctic, Neotropical and Australian species in India. Besides, none of the species is widespread.

ACKNOWLEDGEMENT

We are grateful to Dr. K. N. Mehrotra for providing necessary facilities.

DIVISION OF ENTOMOLOGY,
INDIAN AGRICULTURAL
RESEARCH INSTITUTE,
NEW DELHI-110 012,
April 6, 1978.

R. K. ANAND
SWARAJ GHAI

19. ON SOME INSECTS ASSOCIATED WITH LAC IN INDIA

INTRODUCTION

The lac insect, *Kerria lacca* (Kerr) (Tachardiidae, Homoptera, Hemiptera) thrives on the sap of numerous host plants, and is, in its turn, attacked by a number of parasites and predators. Glover (1934, 1937) recorded 4 encyrtid, 1 eupelmid, 2 apheliniid and 1 eulophid parasites and 2 major predators of the lac insect. Varshney (1976) has not reported any of the insects mentioned in this paper.

The parasitic insects listed in this paper were collected from fresh mature lac caged in specially fabricated cages dark-lined inside except at the holes for fitting glass tubes to study the insects associated with lac insect. The collections were made at the Indian Lac Research Institute, Namkum, Ranchi and its Regional Stations at Kundri (District Palamau, Bihar), Mirzapur (Uttar Pradesh) and Damoh (Madhya Pradesh) as stated against the insects.

OBSERVATIONS AND DISCUSSION

1. **Apanteles angaleti** Muesbeck (Hymenoptera: Braconidae)

Seven specimens (5 ♀♀ and 2 ♂♂) were collected from mature *katki** 1968 crop on *palas* or flame of the forest [*Butea monosperma* (Lam.) Taub.] (Leguminosae: Papilionatae) from Rajnagar (located about 10 km from Damoh in the Forest Compartment No. 107 of the Reserve Forest of Damoh Range, Damoh Forest Division), Damoh.

Two species of the genus *Apanteles*, namely, *A. tachardiae* Cam. and *A. fakhrulhajiae* Mahd., have long been known as endo-parasites on the larvae of *Holcocera pulverea* Meyr. (Lepidoptera: Blastobasidae), a major predator of the lac insect (Mahdihassan 1925). Hence *A. angaleti* was also presumed to be a parasite of *H. pulverea*. In order to confirm this view, 25 cocoons spun over the dead larvae of *H. pulverea* were collected from the

caged lac and the emergence of 18 specimens of *A. tachardiae*, 3 of *A. fakhrulhajiae* and 4 of *A. angaleti* were noted. Hence this is the first record of *A. angaleti* as an endo-parasite of *H. pulverea*.

A. angaleti was first recorded by Narayanan *et al.* (1953) from the environs of New Delhi and subsequently from a number of other places in India. According to these authors, it is an internal larval parasite of the pink bollworm, *Pectinophora gossypiella* Saunders of cotton and appears to be a very efficient and potential parasite in the important cotton growing tracts of India. Charpentier (1956) reports utilization of this parasite as a biotic agent in Louisiana for controlling sugarcane borer. Muesbeck (1956) reports the release of this parasite in Texas against *P. gossypiella* on cotton, and Narayanan *et al.* (1959) report shipment of several thousands of *A. angaleti* to the United States of America for release against *P. gossypiella*.

2. **Tyndarichus** sp. (Hymenoptera: Encyrtidae)

Four specimens were collected from the mature *katki* 1968 crop on *palas* at Mirzapur and numerous specimens from mature *katki* 1969 crop on *bhalia* [*Moghania macrophylla* (Willd.) O. Ktze.] (Leguminosae: Papilionatae) at Namkum and on *palas* at Kundri.

According to Subba Rao, species of *Tyndarichus* Howard are exclusively hyperparasitic on eggs or larvae of lepidopterous pests, very rarely associated with coccids (personal communication). He (1967) has described from India *T. hemiaspidoproctis* reared from *Hemiaspidoproctus cinareus* (Greene) (Coccidae). Thompson (1953) records *Porthetria dispar* L. (Lepidoptera: Lymantriidae) as a host of *Tyndarichus* sp.; *Ooencyrtus kuvanae* How. (Hymenoptera: Encyrtidae) and *P. dispar* L. (Lepidoptera: Lymantriidae) of *T. navae* How.; *Cerambyx cerdo* L. (Coleoptera: Cerambycidae) of *T. rudnevi* Newicki and *Eupithecia castigata* Hb. (Lepidoptera: Geometridae) of *T. scaurus* Wlk. Eady (1960), while describing the new species of *T. clavatus* sp. nov. and *Pseudolitomastix nacoleiae* sp. nov. (Hymenoptera: Encyrtidae); reared *T. clavatus* sp. nov., a hyperparasite of *Nacoleia octasema* Meyr. (Lepidoptera: Pyralidae), from *P. nacikeuae* sp. nov. from New Guinea. De Santis (1967) has reported *T. silvicola* from San Pedro (Argentina).

Since the lac insect is attacked by two major lepidopterous predators namely., *Eublemma amabilis* Moore (Noctuidae) and *H. pulverea* Meyr. (Blastobasidae), it is possible that *Tyndarichus* sp. recorded here occurs either as parasite of the lac insect itself or as a hyperparasite of one or both of these predators.

3. **Thomsonisca** sp. (Hymenoptera: Encyrtidae)

Six specimens were collected from mature *katki* 1969 crop on *palas* at Kundri.

So far, *T. indica* Hayat has been reared from *Aonidiella orientalis* Newst. (Coccidae) on *Ficus* sp. at Aligarh (Hayat 1970). Outside India, *T. typica* (Merc.) has been recorded by Benassy (1961) from Southern France parasitizing *Aulacaspis rosae* (Beh) (Coccidae) infesting raspberry; *T. chionaspidis* Heq. by Hoffer (1959) from Prague and *T. chinaspis* sp. n. on *Chionaspis salicis* Hem. (Coccidae) by Heqvist (1958) from Sweden.

Since *Thomsonisca* sp. has been recorded on various coccids as stated above, it is believed that this species is also parastic on the lac insect together with other encyrtid parasites. The actual role of this parasite is not known.

4. **Camptoptera** sp. (Hymenoptera : Mymaridae)

Four specimens were collected from mature

katki 1969 crop on *palas* at Kundri.

So far, *C. papaveris* Soyka and *C. magna* Soyka have been recorded from Holland (Soyka 1946); *C. loretoensis* Oglobin, *C. missionica* Oglobin, *C. reticulata* Oglobin and *C. angustipennis* Oglobin from Argentina (Oglobin 1947); *C. aula* Deb. from Belgium (Debauche 1948); *C. ellifranzae* Str. from Germany (Strassen 1950); *C. lapponica* Heq. at Sweden (Heqvist 1954); *C. strobilicola* Heq. from Norway (Heqvist 1956), and *C. pechlaneri* Soyka, *C. cardui* Foerst and *C. stammeri* Soyka by Annecke and Dout (1961).

The association of Mymaridae with lac is a new record and its role is yet unknown.

5. **Scatopse** sp. (Diptera : Scatopsidae)

Two specimens were collected from mature *katki* 1968 crop on *palas* at Mirzapur.

This is the first record of the association of a Diptera with lac and its role is yet to be determined.

ACKNOWLEDGEMENTS

We are grateful to Dr. T. P. S. Teotia, Director, Indian Lac Research Institute, Namkum for his keen interest and to Dr. B. R. Subba Rao and Dr. R. W. Crosskey, Commonwealth Institute of Entomology, London, for determining the insects.

INDIAN LAC RESEARCH INSTITUTE,
NAMKUM,
RANCHI-834 010,
August 22, 1978.

R. S. GOKULPURE
B. P. MEHRA
P. SEN
JAWAHIR LAL

REFERENCES

ANNECKE, D. P. & DOUT, R. L. (1961): The genera of the Mymaridae, Hymenoptera; Chalcidoidea. *Ent. Mem. Dep. Agric. S. Afri. 5*: 1-71.

BENASSY, C. (1961): Contribution to the study of the influence of some ecological factors on the limitation of out breaks of Diaspine coccids (In French). *Ann. Epiphyt. 12*: 157.

CHARPENTIER, L. J. (1956): 1954 studies of parasites for sugarcane borer control in Louisiana. *J. eco. Ent. 49*: 267-68.

DEBAUCHE, H. R. (1948): Etude sur les Mymarommidae et les Mymaridae de la Belgique (Hymenoptera-Chalcidoidae). *Mem. Mus. Hist. nat.* Belg., Brussels, No. 108; 247 pp.

DE SANTIS, L. (1967): Adiciones a'la fauna Argentina de Encyrtidos 1. (Hymenoptera: Chalcidoidea). *Acta. Zool. Lilloana 23*: 67-75.

EADY, R. D. (1960): A new genus and two new species of Encyrtidae (Hymenoptera: Chalcidoidea) from the banana Scab moth, *Nacoleia octasema* (Meyr.) *Bull. ent. Res. 50*: 667-670.

GLOVER, P. M. (1934): Check list of the Chalcidoidea bred at Namkum from the lac insect, *Laccifer lacca* with some notes as regards their function, economic importance and control. *Bull. Indian Lac Res. Inst. 20*: 14 pp.

——————— (1937): Lac cultivation in India. Indian Lac Research Institute, Namkum, Ranchi, 147 pp.

HAYAT, M. (1970): New species of Encyrtidae (Hymenoptera: Encyrtidae) reared from Coccids. *Mushi 44*: 55-63.

HEQVIST, K. J. (1954): Zwei neue Mymariden (Hym.) aus Schweden. *Ent. Tidskr. 75*: 272-275.

——————— (1956): A new species of *Camptoptera* from Norway (Hymenoptera: Mymaridae). *Norsk. ent. Tidskr.* 10: 37-39.

——————— (1958): Notes on Chalcidoidea II. Chalcids reared from *Chionaspis salicis* L. *Ent. Tidskr.* 79: 55-7.

HOFFER, A. (1959): Miscellanea Encyrtidologica III. (Hym. Chalcidoidea). *Acta. ent. Mus. nat.* 33: 5-36.

MAHDIHASSAN, S. (1925): Some insects associated with lac and a symbiotic representation of their inter-relationship, *J. Sci. Assoc. Maharaja College,* Vizianagaram. 2: 64-88.

MUESBECK, C. W. F. (1956): Some braconid

parasites of the Pink Boll worm, *Pectinophora gossypiella* (Saunders). *Boll. Lab. Zool.*, Portici. 33: 57-58. (fide *Rev. appl. Ent.* Ser. A. 1957, 45: 378).

NARAYANAN, E. S.; ANGALET, G. W.; SUBBA RAO, B. R. & D'SOUZA, G. I. (1953): A technique for mass breeding of *Apanteles* n. sp. (Braconidae: Hymenoptera). *Curr. Sci.* 22: 21.

NARAYANAN, E. S.; SUBBA RAO, B. R. & GANGRADE, G. A. (1959): The biology and rate of reproduction and morphology of the immature stages of *Apanteles angaleti* Muesbeck (Hymenoptera: Braconidae). *Beitr. Ent.* 6: 296-320 (fide *Rev. appl. Ent.* Ser. A., 1959, 47: 73).

OGLOBLIN, A. (1947): Las especies nuevas del genero *Camptoptera* de Misiones (Mymaridae, Hym.). *Acta. Zool. Lilloana* 4: 493-508.

SOYKA, W. (1946): Revision einiger Mymaridengattungen. *Zbl. Gesamt. Gb. Ent.* 1: 33-44.

SUBBA RAO, B. R. (1967): Description of some new species of encyrtids from India. *Bull. ent.* 8: 1-7.

STRASSEN, R. ZUR. (1950): Ein never vartreter der Gattung *Camptoptera. Senckenbergiana* 31: 145-150.

THOMPSON, W. R. (1953): A catalogue of the parasites and predators of insect pests. Hosts of the hymenoptera (Galliceratid to Evaniid) Sect. 2 Part 3. The Commonwealth Institute of Biological Control, Canada: 271.

VARSHNEY, R. K. (1976): A check list of insect parasites associated with lac. *Oriental Insects.* 10 (1): 55-78.

20. A FLOURISHING COLONY OF *COPTOTERMES HEIMI* (WASM.) (INSECTA : ISOPTERA) IN A NAVAL BOAT

Coptotermes heimi is a serious wood-destroying termite of India (Sen-Sarma *et al.* 1975). It attacks timber structures in building, wooden poles, posts, timbers used in wooden bridges and wood lying in the open. It occurs throughout the Indian subcontinent. It has also been recorded as an introduced species in some parts of South-East Asia (Lever 1952; Gay 1969).

Species of the genus *Coptotermes* normally live in subterranean colonies and maintain soil connection for their sustenance. However, instances are on record where fully established colonies (without, maintaining soil connections) of some species of *Coptotermes* have been reported (Mathur & Sen-Sarma 1959; Sen-Sarma *et al.* 1975). The present note records the establishment of a flourishing colony of *Coptotermes heimi* in a Naval Boat, Bombay without maintaining soil connection. The colony comprised of a primary queen, workers, soldiers and nymphs. This seems to be the first record of a colony of *Coptotermes heimi* in a naval boat in India which remains on the high sea most of the time. The presence of the primary queen leads to the conclusion that the colony was established by the swarming alates presumably during the period when the boat was docked in a dry dock. As the alates are weak fliers, successful landing of alates in the boat in the high sea is ruled out. Subsequent availibility of food, regular source of moisture and other factors were conducive for the establishment of a viable colony. This discovery is important in many respects. It indicates that a colony of *C. heimi* can survive without maintaining soil connection provided a source of moisture is available. It also shows that this species of termites can pose serious problems in sea vessels and is capable of being introduced to other geographical regions. The colony was collected by the Naval Metallurgical Laboratory, Bombay to whom our thanks are due.

FOREST ENTOMOLOGY BRANCH,
FOREST RESEARCH INSTITUTE & COLLEGES,
DEHRA DUN,
January 3, 1978.

M. L. THAKUR
P. K. SEN-SARMA

REFERENCES

GAY, F. J. (1969): Species introduced by man. *In*—Biology of Termites, Vol. I: 459-494 (Academic Press, New York).

LEVER, R. J. W. (1952): New or recently introduced insect pests in Singapore, absent from the Federation of Malaya. *Malayan Agri. J., 25*: 214-217.

MATHUR, R. N. AND SEN-SARMA, P. K. (1959): Notes on the habits and biology of Dehra Dun termites, Pt. I. *J.T.D.P.A. India,* Dehra Dun, *5*(3): 3-9.

SEN-SARMA, P. K., THAKUR, M. L., MISHRA, S. C. AND GUPTA, B. K. (1975): Studies on wood destroying termites in relation to natural termite resistance of timber. *Final Tech. Rept. P.L. 480 Project No. A7-FS-58* (1968-73): 1-187.

21. ON THE EULITTORAL PALAEMONID SHRIMP (CRUSTACEA, DECAPODA) OF VISAKHAPATNAM COAST

(*With a text-figure*)

During a visit to the Ramakrishna Beach of Visakhapatnam, on March 23, 1977, a few shrimps were observed lurking beneath some semi-exposed rocks. In all, four shrimps were collected and after noting the colour, preserved. Again, on April 20, 1977 the same species of shrimp was collected from the rock-pools of Bimilipatnam coast (25 km north of Visakhapatnam).

The shrimps were identified as *Palaemon* (*Palaemon*) *belindae* (Kemp, 1925). This species was originally described by Kemp (1925) as *Leander belindae,* based on specimens from Kilakarai (Gulf of Mannar) and Cape Comorin. Holthuis (1950) defined the genus *Palaemon* Fabricius and included Kemp's *belindae* under the nominate subgenus *Palaemon*. To date, *P.* (*P.*) *belindae* does not appear to have been recorded beyond the type-locality. Although Kemp's original description is excellent, some supplementary notes and illustrations are given here.

Of the nine specimens, seven are females (all five belonging to the April 20, 1977 sample are ovigerous) and two are males. Measurements of the largest specimen (♀): body length 37.0 mm, carapace length 8.0 mm and rostrum length 6.0 mm; correspond-

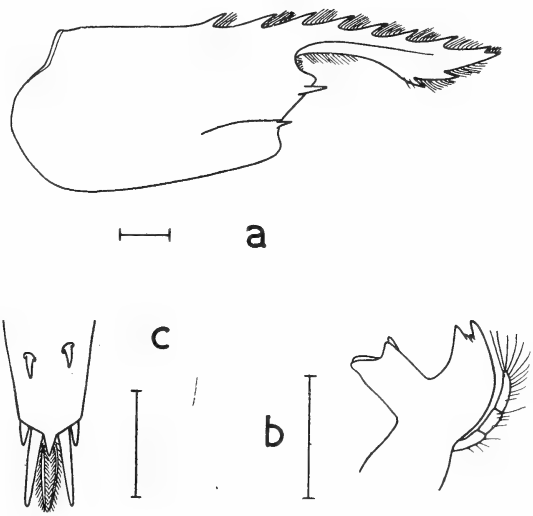


Fig. 1. *Palaemon* (*Palaemon*) *belindae* (Kemp, 1925). a. carapace and rostrum; b. mandible; c. distal part of telson. (Scale = 1.0 mm).

ing measurements of the smallest specimen (♂): 16.5 mm, 3.0 mm and 2.5 mm respectively. Rostral teeth formula 7-8/2-3; only in one specimen does the ventral margin bear three teeth.

The carapace, rostrum, mandible and distal part of telson are illustrated in Figure 1. Kemp (1925) made no mention of the branchiostegal suture, which is very distinct as shown in Figure la. Colour of the present specimens agrees with the description of Kemp; However, Kemp did not mention the conspicuous colour pattern of the antennal flagellae, which bear dark (greenish-maroon) and pale (pink) alternating bands.

Johnson (1968), writing about prawns of marine littoral weed beds at Singapore, stated that bottom-living prawns occur in, or invade the littoral weed beds. This appears to be the case with *P.(P.) belindae* also, because, on both occasions this species was found among various seaweeds.

From the coastal waters of mainland India, five species of the subgenus *Palaemon* are known, namely, *serrifer* (Stimpson), *pacificus* (Stimpson) *sewelli* (Kemp), *belindae* (Kemp) and *concinnus* Dana (Kemp. 1925; Dutt & Ravindranath, 1974). From the literature it appears that all these are littoral species, and mutually exclusive in their distribution except *pacificus* and *belindae* which have been recorded from Cape Comorin.

The following key based on Kemp (1925), Holthuis (1950) and present observations, may be used to distinguish the five Indian species of the subgenus *Palaemon*:

KEY TO THE SPECIES OF *Palaemon* (*Palaemon*)

1. Branchiostegal suture originates some distance above the branchiostegal spine; first pleopod of adult male with a rudimentary appendix interna .... *P.* (*P.*) *concinnus*

— Branchiostegal suture originates very close to the branchiostegal spine; first pleopod of adult male without even a rudiment of appendix interna 2

2. Branchiostegal spine inserted behind the antero-lateral margin of carapace; dactylus of pereopods 3-5 extremely slender.................... .... *P.* (*P.*) *sewelli*

— Branchiostegal spine inserted on the antero-lateral margin of carapace; dactylus of pereopods 3-5 not slender 3

3. Dorsal rostral teeth 9-16, usually 11 or 12, most crowded over the region of the eye.......... .... *P.* (*P.*) *serrifer*

— Dorsal rostral teeth 6-11, usually 7-9, not crowded over the region of the eye..........4

4. Propodus of pereopods 3-5 distally dilated and armed with 4-6 stout spines; ventral rostral teeth usually 2.............. *P.* (*P.*) *belindae*

— Propodus of pereopods 3-5 not dilated distally and with only 1 or 2 slender spines; ventral rostral teeth usually 4........*P.* (*P.*) *pacificus*

ACKNOWLEDGEMENTS

I wish to thank Prof. Y. Radhakrishna, Head of the Department, for facilities and encouragement, and Mr. P. Balasundar Reddy for his assistance in collecting the Bimilipatnam sample.

K. RAVINDRANATH

DEPARTMENT OF ZOOLOGY,
NAGARJUNA UNIVERSITY,
NAGARJUNANAGAR P.O.,
GUNTUR 522510,
December 23, 1977.

REFERENCES

DUTT, S. AND RAVINDRANATH, K. (1974): A new record for *Palaemon* (*Palaemon*) *concinnus* Dana 1852 (Decapoda, Palaemonidae), from India. *Curr. Sci.*, *43*(4): 123-124.

HOLTHUIS, L. B. (1950): The Decapoda of the Siboga Expedition. Part X. The Palaemonidae. I. Subfamily Palaemoninae. *Siboga Exped. Monogr.*, *39a*9: 1-268.

JOHNSON, D. S. (1968): Prawns of marine littoral weed beds at Singapore. *Malayan Nat. J.*, *21* (supplement): xxi.

KEMP, S. (1925): Notes on Crustacea Decapoda in the Indian Museum. XVII. On various Caridea. *Rec. Indian Mus.*, *27*(4): 249-343.

22. FIRST RECORD OF *LUMBRICUS CASTANEUS* (SAVIGNY) FROM INDIA (LUMBRICIDAE: OLIGOCHAETA)

Lumbricus castaneus (Savigny) is known to occur at various localities in New Zealand, North America and Europe (Gates 1972). This species is being reported here for the first time from India, collected from Mashobra in Himachal Pradesh. Two other species, namely *Lumbricus rubellus* Hoffmeister and *Lumbricus terrestris* Linnaeus have been previously reported from India, the former from Nicobar Island (Stephenson 1923) and the latter from Simla (Gates 1951). Another species, *Bimastos eiseni* (Levinson) recorded from Naini Tal (Stephenson 1923), which according to Gates (1958) is not *Bimastos*, has now been doubtfully referred to belong in *Lumbricus* (Reynolds *et al.* 1974).

Lumbricus castaneus (Savigny)

1826. *Enterion castaneum* Savigny, *Mem. Acad. Sci. Inst. France 5*: 180. (Type locality —Paris).

1972. *Lumbricus castaneus*, Gates, *Trans. Amer. Phil. Soc.*, *62* (7): 114.

Material examined.—16 ex; Mashobra, Distt. Simla, Himachal Pradesh; 8.ix.1971; H. P. Agrawal.

Description.—Length 20-28 mm. Diameter 2-3 mm. Segments 70-91. Colour reddish-violet on dorsum and yellowish ventrally. Prostomium tanylobous. First dorsal pore at 6/7-7/8. Setae closely paired; *AB*>*CD*, *AA*=*BC*, *DD* anteriorly = about $\frac{1}{2}$C (but posteriorly < $\frac{1}{2}$C). Clitellum saddle-shaped, XXVIII-XXXIII; tubercula puberatis longitudinal bands, slightly lateral to *B*, at $\frac{1}{2}$XXVIII, XXIX-XXXII. Male pores on XV, in *BC*, without tumescences. Genital tumescences around setae *A* and *B* on X, XXIX-XXXII. Quadrithecal; pores in *CD*, at 9/10-10/11. Nephropores obvious, behind XV irregularly alternating with asymmetry between levels just above *B* and well above *D*.

Septa thin and delicate. Oesophagus widened and markedly moniliform in XI-XII; gizzard in XVII; typhlosole beginning in region of XXI-XXII and ending in 66th to 75th segments, leaving 4, 8 and 13-17 atyphlosolate segments from posterior end. Calciferous sacs in X, horizontal, opening into gut posteriorly and ventrally at the insertion of septum 10/11. Excretory system holoic, nephridial bladders J-shaped. Extra-oesophageal vessels joining dorsal trunk along 9/10; hearts in VII-XI. Holandric; testis sacs present; seminal vesicles in IX, XI and XII; spermathecal ducts short, entering the parietes at 9/10 and 10/11.

Distribution.—India: Mashobra (Himachal Pradesh). Extralimital: New Zealand, Canada, U.S.A., Mexico, Europe.

Remarks.—According to Gates (1958), the lumbricids in India are domiciled only at hill

resorts where Europeans have resided in the past. Further, he states that they have been transported from Europe to these places alongwith the earth surrounding the roots of exotic plants. The occurrence of *Lumbricus castaneus* (Savigny) at Mashobra might be due to this phenomenon like the other Indian lumbricid species. The lumbricids are able to withstand freezing temperatures for long periods (Gates 1958).

KEY FOR THE IDENTIFICATION OF INDIAN SPECIES OF *Lumbricus*.

1. Athecal; clitellum begins in front of XXV; tubercula puberatis absent. .... *Lumbricus eiseni*
   Thecal; clitellum begins behind XXV; tubercula puberatis present 2
2. Clitellum begins behind XXX. ....*Lumbricus terrestris*
   Clitellum begins in front of XXX 3
3. Clitellum XXVI, XXVII-XXX, XXXI, XXXII; tubercula puberatis on XXVIII-XXXI ....*Lumbricus rubellus*
   Clitelllum XXVIII-XXXIII; tubercula puberatis on XXIX-XXXII ....*Lumbricus castaneus*

ACKNOWLEDGEMENTS

I am grateful to Dr. S. K. Khera, Joint Director-in-charge, Zoological Survey of India for facilities to carry out this work. Thanks are also due to Dr. Raj Tilak, Superintending Zoologist, Zoological Survey of India for his valuable suggestions.

HIGH ALTITUDE ZOOLOGY FIELD STN.,
ZOOLOGICAL SURVEY OF INDIA,
SOLAN (H.P.),
April 4, 1977.

J. M. JULKA

REFERENCES

GATES, G. E. (1951): On the earthworms of Saharanpur, Dehra Dun, and some Himalayan hill stations. *Proc. natl. Acad. Sci. India,* (B) *21*: 16-22.

——————— (1958): Contributions to a revision of the earthworm family Lumbricidae. II. Indian species. *Breviora,* No. 91: 1-16.

——————— (1972): Burmese earthworms. *Trans. Amer. Phil. Soc., 62* (7): 1-326.

REYNOLDS, J. W., CLEBSCH, E. E. C. AND REYNOLDS, W. M. (1974): The earthworms of Tennessee (Oligochaeta). 1. Lumbricidae. *Bull. Tall Timbers Res. Stn.,* No. 17: 1-133.

STEPHENSON, J. (1923): Fauna of British India, Oligochaeta—Taylor and Francis, London: 1-518.

23. FAUNAL ASSOCIATIONS OF LITTORAL SPONGES IN AND AROUND BALUGAON IN CHILKA LAKE (LAGOON)

The littoral system of Chilka lake, the largest brackish water lagoon situated on the east coast of India supports luxuriant growths of algae and sedentary animal growths on the boulders and shingle of various islands in the lake (Annandale & Kemp 1915, 1916; Sewell & Annandale 1922; Parija & Parija 1946). The littoral plant and animal growths are of immense ecological importance as they form favourable habitats for a variety of organisms which in turn attract higher trophic level organisms for foraging (Gislen 1929; Dahal 1948; Round *et al.*, 1961; Perera & Arudpragasam 1966; Sarma & Ganapati 1972; Rao & Rao 1973). The organisms associated with these sessile growths at Chilka are little known

except for isolated taxonomic accounts of individual groups (Annandale & Kemp 1915; Sewell & Annandale 1922). Sarma & Satapathy (1978) recently reported on the phytal-faunal associations in and around Balugaon in Chilka lake. In the present paper the results of a study on the qualitative and quantitative distribution pattern of epibiotic fauna of two species of sponges of the lake are dealt with.

Samples of two species of encrusting sponges, namely *Spongilla* sp. and *Laxosuberites lacustris* Annandale occurring at Kalijugeswar, Chadheiga and Kalijai islands situated in and around Balugaon were collected during Jan.-Sept. 1977 and analysed as outlined by Rao & Rao (1973).

The qualitative composition and mean densities along with percentage composition based on an analysis of samples of diverse faunal elements inhabiting *Spongilla* and *Laxosuberites* are presented in Tables I and II respectively.

31 species belonging to seven major taxa namely Foraminifera (4), Polychaeta (2), Copepoda (11), Amphipoda (9), Isopoda (2), Tanaidecea (1), Bivalvia (2) have been identified. Besides, several species of undetermined identity belonging to Nematoda, Ostracoda and adult insects and larvae are found to exist associated with sponges.

On an average *Spongilla* supported a mean density of 852 animals/100 cc, of which amphipods, nematodes, tanaidaceans and foraminiferans were dominant. In the January samples of *Spongilla* as may as 57000 gemmules/100 cc were observed. *Laxosuberites* was found to harbour a mean density of 2742 animals/100 cc, consisting of nematodes, amphipods, copepods, tanaidaceans, ostracods as the dominant forms in the order of their abundance respectively.

The general morphology of the host animal, the sediment accumulated on it and the physicochemical parameters of the environment appear to influence the composition and abundance of the epibiotic organisms (Dahal 1948; Round *et al.* 1961; Sarma & Ganapati 1972; Rao & Rao 1973). The loosely aggregated *Spongilla* growths laden with numerous monaxon spicules and less sediment deposition offer fewer biospaces for animal inhabitation and as such it supported few species and low density of organisms. The compact mat-forming *Laxosuberites* with well developed cortex affording more surface area for animal colonisation and sediment settlement supported a high species diversity and faunal density. However, foraminiferans were more on *Spongilla* than on *Laxosuberites* as the rough body wall of the former offers more grip to them than the smooth surface of the latter.

There are no published census of sponge associates from the Indian coast to compare and contrast with the present observations. The density of lake sponge associates is many times higher than that reported for the littoral sponge *Halichondria panicea* at Oregon (1.15 organisms/cm^3) by Long (1968).

From the foregoing account it is clear that the littoral sessile animal growths serve as an oikos for a variety of morphologically and biologically divergent organisms and as such play a vital role in the bio-economy of the littoral system.

Grateful thanks are due to the authorities of Regional College of Education, Bhubaneswar (N.C.E.R.T.) for all the facilities provided for carrying out the present work.

TABLE I

QUALITATIVE COMPOSITION OF EPIBIOTIC FAUNA OF *Spongilla* sp. AND *L. lacustris* ANNANDALE

Species	*Spongilla* sp.	*L. lacustris*
FORAMINIFERA:		
Rotalia sp.	+	+
Spirillina sp.	+	–
Cibicides sp.	+	–
Trochammina sp.	+	–
NEMATODA:		
Undetermined spp.	+	+
POLYCHAETA:		
Nereis chilkensis Southern	+	+
Fabricia spongicola Southern	+	+
OSTRACODA:		
Undetermined spp.	+	+
COPEPODA:		
Oithona sp.	–	+
Laophonte sp.	+	+
Nitocra sp.	+	+
Mesochra sp.	–	+
Harpacticus sp.	+	+
Ergasilus sp.	–	+
Cyclopina sp.	–	+
Halicyclops sp.	–	+
Cyclops sp.	–	+
Mesocyclops sp.	–	+
Saphirella sp.	–	+
AMPHIPODA:		
Talorchestia martensi (M. Weber)	+	+
Hyale brevipes Chevereux	+	+
Orchestia platensis Kroyer	+	+
Photis longicaudata (Bate & Westew)	+	–
Photis sp.	+	+
Paracalliope fluviatilis (G. M. Thomson)	+	+
Maera sp.	+	+
Niphargus chilkensis Chilton	+	+
TANAIDACEA:		
Apseudus chilkensis Chilton	+	+
ISOPODA:		
Exosphaeroma parva Chilton	+	+
Ligia exotica Roux	+	–
ADULT INSECTS & LARVAE:		
Undetermined sp.	+	–
BIVALVIA:		
Modiola undulata Dunker	+	+
Modiola striatula Hanley	+	+

Present +; Absent –

TABLE II

MEAN NUMERICAL DENSITY DISTRIBUTION AND PERCENTAGE COMPOSITION OF EPIBIOTIC FAUNA OF *Spongilla* sp. and *Laxosuberites lacustris* ANNANDALE.

Animal groups	*Spongilla* sp. Nos./100 cc.	*Spongilla* sp. % Composition	*L. lacustris* Nos./100 cc.	*L. lacustris* % Composition
Foraminifera	107	12.55	10	0.36
Nematoda	250	29.30	1333	48.60
Polychaeta	25	2.93	15	0.54
Ostracoda	6	0.70	67	2.45
Copepoda	10	1.20	167	6.10
Amphipoda	273	32.00	1007	36.73
Tanaidacea	116	13.60	93	3.39
Isopoda	47	5.60	17	0.62
Adult Insects & Larvae	3	0.35	—	—
Bivalvia	15	1.76	33	1.20
Total	852	99.99	2742	99.99

DEPARTMENT OF LIFE SCIENCES,
REGIONAL COLLEGE OF EDUCATION, (NCERT),
BHUBANESWAR, (ORISSA).

A. L. N. SARMA
D. G. RAO

NAYAGARH COLLEGE,
NAYAGARH, (ORISSA),
August 25, 1978.

S. SATAPATHY

REFERENCES

ANNANDALE, N. AND KEMP, S. (1915): Fauna of Chilka Lake; Introduction. *Mem. Indian Mus.* 5 (1): 1-20.

——————— (1916): 'Fauna of the Chilka Lake. Mollusca, Gastropoda and Lamellibranchiata, with an account of the anatomy of the common Solon'. *Mem. Indian Mus.*, 5(4): 327-74.

DAHAL, E. (1948): On the smaller Arthropoda of marine algae, especially in the polyhaline waters off the Swedish west coast. *Undersokningar over Orsund.*, 35: 1-193.

GISLEN, T. (1929): Epibioses of the Gullman Fjord I. *Kristineberg. Zool. Sta.* 3: 1-123.

LONG, R. EDWARD (1968): The associates of 4 species of marine sponges of Oregon and Washington. *Pac. Sci.* 22(1): 357.

PARIJA, P. & PARIJA, B. (1946): Algal succession on a rocky island named Chadaiguha, in the Chilka Lake. *Indian Bot. Soc. M.O.P. Iyengar. Commem. Vol.* (Ed. by B. Sahani): 375-379.

PERERA, M. M. &. ARUDPRAGASAM, K. D. (1966): Animals living in association with *Ostrea virginica* at Batticaloa. *Ceylon. Jour. Sci. Biol. Sci.* 6(1): 20.

RAO & RAO (1973): The epibiotic flora and fauna of Serpulid band in the littoral region of Mukkam coast., *Rivista Di Idrobiologia.* Vol. XII-Fasc. 2/3: 71-95.

ROUND, F. E., SOLANE, J. F., EBLING, F. J. AND KITCHING, J. A. (1961): The ecology of the Lough Ine X—The hydroid *Sertularia opercularia* and its associated flora & fauna: Effects of transference to sheltered water. *J. Ecol. 49* (3): 617-629.

SARMA, A. L. N. & GANAPATI, P. N. (1972): The faunal associations of algae in the intertidal region of Visakhapatnam. *Proc. Ind. Nat. Sci. Acad.* 38B: 380-396.

SARMA, A. L. N. & S. SATAPATHY (1978): A note on the phytal fauna in and around Balugaon in Chilka Lake. *Curr. Sci. 47* (7): 242-245.

SEWELL, R. B. S. & ANNANDALE, N. (1922): Fauna of the Chilka Lake: The hydrography and invertebrate fauna of Rambha Bay. *Mem. Indian. Mus. 5* (10): 667-710.

24. THE BROADCASTING OF KARVI SEED

On the 26th of May 1977 while out on a morning walk at Mahableshwar we had the good fortune to observe the mechanics whereby Karvi plants (*Karvia callosa*) shed and broadcast their seed. No record is found of the characteristic behaviour in this group of plants, so we give a detailed account of what we saw.

The Karvi or Strobilanthes had flowered *en masse* during the monsoon of 1976, and by May the plants were dead and sear with the capsules containing the seeds (several on each core), well matured but enclosed and hidden by the dry bracts forming the cores.

On the afternoons and evenings of the 24th and 25th of May there had been heavy thunder shower which had laid the dry summer dust and soaked the soil. The morning of the 26th was bright and sunny. About 10 a.m. we came to the brow of the hill overlooking an open Karvi covered slope descending into the valley. J. D. P. was intrigued by continu-

ously occurring sharp little ticking sounds from among the Karvi and realized that the ticking was caused by Karvi capsules suddenly splitting open and catapulting the seeds outwards and upwards, sometimes to a distance of over 4 feet from the parent plant.

We spent some time in the area observing the busy broadcasting operations. It was noticed that they were actively under way only in areas which were directly under sunlight. On contours of the slope still in shade there was hardly any seed shedding activity, and the capsules were completely covered by bracts, whereas in the active areas the bracts had opened out slightly exposing the capsules to perform their broadcasting function unhindered.

The capsules are dark brown, flat, shaped like a broad, symmetric spearhead, pointed both at the apex and base, *c.* 18×8 mm. A seam runs down the middle of both flat sides from apex to base. The split occurs along this seam. The two parts or valves of the split capsule sometimes remain open, joined at the base, but quite often drop off with the force of their own little explosions.

Each capsule normally contains a pair of seeds, ovoid, paper thin flakes, off white in colour, which are buoyant on the wind as they are flung out from the capsule and so are spread more or less evenly. Though quite conspicuous on the wet dark brown earth yet strangely no birds seemed to be interested.

This and other Karvi patches were visited on subsequent days in the hope of witnessing another mass broadcasting but nothing notable occurred except for an occasional capsule splitting which would have gone quite unnoticed if not expectantly watched for.

During the next fortnight the earth remained continuously damp. The moist seeds discoloured slightly and stuck to the soil with mildew-like filaments firmly enough not to be washed down by heavy rain.

By the 14th of June when we left the hill, most of the Karvi had shed their seed. They must have done so on different days at different times, unobserved, unappreciated and unrecorded. It was rare good fortune that in the first instance we came upon the right place on the right day, at the right time. How rare the good fortune was can be appreciated when one considers that Karvi flowers and seeds once in eight years.

D. J. PANDAY
J. D. PANDAY

4-A, Rashmi,
Carmichael Road,
Bombay-400 026,
September 19, 1977.

25. THE GENUS *AMOMUM* ROXB. (ZINGIBERACEAE) IN ANDAMAN AND NICOBAR ISLANDS

(*With two plates*)

Introduction

The first species of *Amomum* to be reported from Andaman and Nicobar Islands was *A. fenzlii* which was described with illustrations by Kurz in 1876. Subsequently Baker in 1892 reported *A. aculeatum* Roxb. from S. Andaman Island based on a collection by Kurz. Recent intensive botanical explorations in different islands revealed that in addition

to the above, another species *A. maximum* Roxb. also occurs in S. Andaman Islands. *A. fenzlii* is endemic to Nicobar group of islands where it is common in Car Nicobar, Katchal and Great Nicobar Islands. This species is not found in Andaman group of islands. *A. aculeatum* Roxb., a species found in Malaysia & Java has never been collected from these islands ever since Kurz made his collection in 1870. Recently this species was again collected from dense forests in S. Andamans along with another interesting rare species *A. maximum* Roxb. Roxburgh's original description of *A. maximum* Roxb. was based on specimens brought from 'Malay Islands' by Colonel Kyd. It is surprising that subsequent authors Ridley (1924) and Holttum (1950) have never reported this species as occurring in Malaya. Most probably the 'Malay Islands' cited by Roxburgh refers to Andamans where Col. Kyd made collections in 1791. Backer & Bakh. f. (1968) give *A. dealbatum* Roxb. a species occurring in NE. India, as synonymous to *A. maximum* Roxb. However it is doubtful whether they really belong to same species. The specimens studied by us from Andamans and also the original description by Roxburgh differ from *A. dealbatum* in longer peduncles of inflorescences, elliptic-obovate, entire and not emarginate lip, shorter filaments and aromatic pungent fruits and seeds. Moreover recent studies of Assam plants of *A. dealbatum* Roxb. by Rao & Verma (in *Bull. Bot. Surv. India* 14: 135. 1972) indicate that the leaves are brown pubescent beneath whereas the Andaman plants of *A. maximum* Roxb. show whitish pubescence.

The descriptions and illustrations given were drawn up from fresh plants.

KEY TO SPECIES

1a. Inflorescence dense-flowered with many closely imbricate bracts; anther not crested; lip narrow, up to 1.2 cm broad, as long as corolla lobes, longitudinally folded, inflexed at tip. 1. *A. fenzlii*

1b. Inflorescence lax-flowered with fewer loosely arranged bracts; anther crested; lip broader, longer than corolla lobes, not folded longitudinally, reflexed at tip.

2a. Petioles very short; lip wedge-shaped, 3-lobed at apex; anther crest 3-lobed; filaments 1.2—1.4 cm long. 2. *A. aculeatum*

2b. Petiole long; lip elliptic-obovate, entire; anther crest truncate; filaments shorter, 2-3 mm long. 3. *A. maximum*

1. **A. fenzlii** Kurz in J. As. Soc. Beng. 45 (3): 154, t. 12. 1876; Baker in Hook. f. Fl. Brit. Ind. 6: 234.1892.

Plants 3-4 m tall, leaves broadly lanceolate to oblong lanceolate, obtuse to obliquely subattenuate at base, shortly acuminate at apex, 40-85 cm long, 11-15 cm broad, glabrous, dark green above, pale beneath; petiole 1.5-2.5 cm long, 4-6 mm thick, glabrous; ligules broadly ovate, obtuse to subacute at apex, ciliate at margins, 1.5-2.0 cm long, 1.0-1.5 cm broad. *Inflorescences* arising from the rhizome, glabrous, densely flowered; peduncle 8-18 cm long; sterile bracts elongate-ovate, 4-6 cm long, 1.2-1.6 cm broad, reddish brown, ciliate at margins; floral bracts ovate to linear obovate, 3-5 cm long, 1.0-2.5 cm broad; reddish; bracteoles tubular at base, bifid at apex, 1.9-2.2 cm long, pubescent. *Calyx* 2.0-2.5 cm long, oblique and 2-fid at mouth, pubescent. *Corolla-tube* 1.5-2.0 cm long; lobes 3, narrowly obovate, 1.8-2.0 cm long, 3-4 mm broad, pubescent outside. *Labellum* elongate-rhomboid, attenuate at base, narrowed towards apex, sometimes obscurely 3-lobed, 1.8-2.0 cm long, 0.8-1.2 cm

broad; lobes inflexed, pale red, glabrous. *Anther* 5-6 mm long, 2-3 mm broad, inappendiculate, ciliate towards base; filaments 4-5 mm long, 2-3 mm broad; staminodes absent. *Ovary* 4-5 mm long, 3.0-3.5 mm thick, densely villous; style 2.2-2.5 cm long, pubescent; stylodes 2, ± 4 mm long, 2-3 mm broad, pubescent at apex; stigma trigonously capitate, glabrous. *Capsules* obovoid, irregularly ridged, 2.0-2.5 cm long, 1.0-1.5 cm broad, pubescent.

CAR NICOBAR ISLAND: Arong, Sea Level, 21 May 1975, *N. G. Nair* 2631 (PBL); KATCHAL ISLAND: Mildera, ± 30 m, 9 May 1975, *P. Chakraborty* 1531 (PBL); GREAT NICOBAR ISLAND: Campbell Bay, ± 75 m, 19 May 1975, *N. P. Balakrishnan* 2690 (PBL); East-West Road, 33 KM from Campbell Bay, ± 165 m., 22 July 1976; *N. P. Balakrishnan* 3942 (PBL).

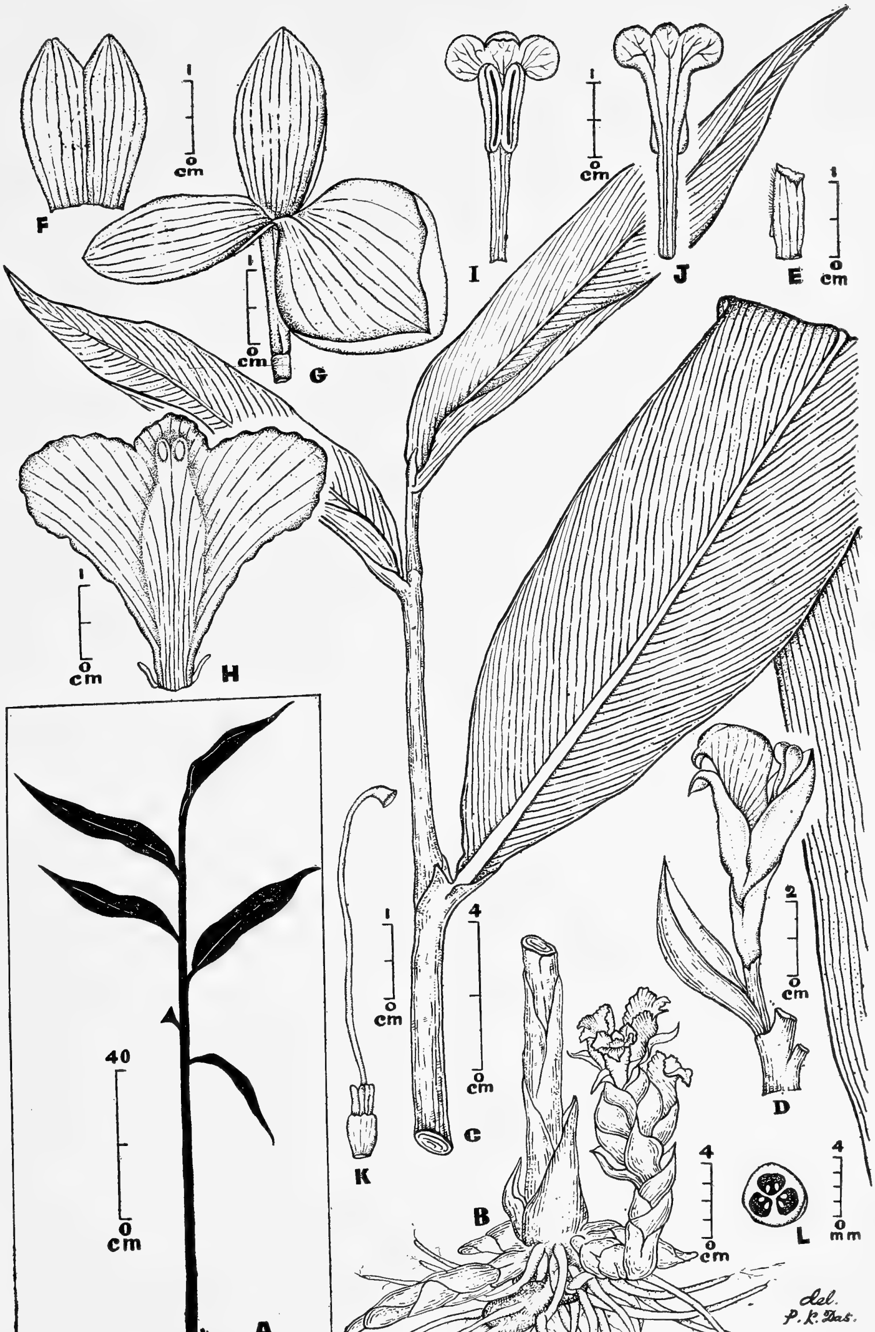
Distribution: Endemic to Nicobar Islands.

Notes: This species is very common in Great Nicobar Island especially in inland hill forests wherever there is some sunshine penetrating and reaching the forest floor. In a stray plant (*Balakrishnan* 3942), the inflorescences were found to be arising from the tip of the pseudostems amidst leaves and also in the same plant mature fruits were found at the base of the stem on rhizome! This may be due to an accidental prolongation of peduncle through the pseudostem.

In the illustration given by Kurz (l.c., t. 12), the figures labelled by him as staminodes are actually stylodes. Study of several flowers from different localities indicate complete absence of any staminodes at the base of lip, in constrast to the following two species.

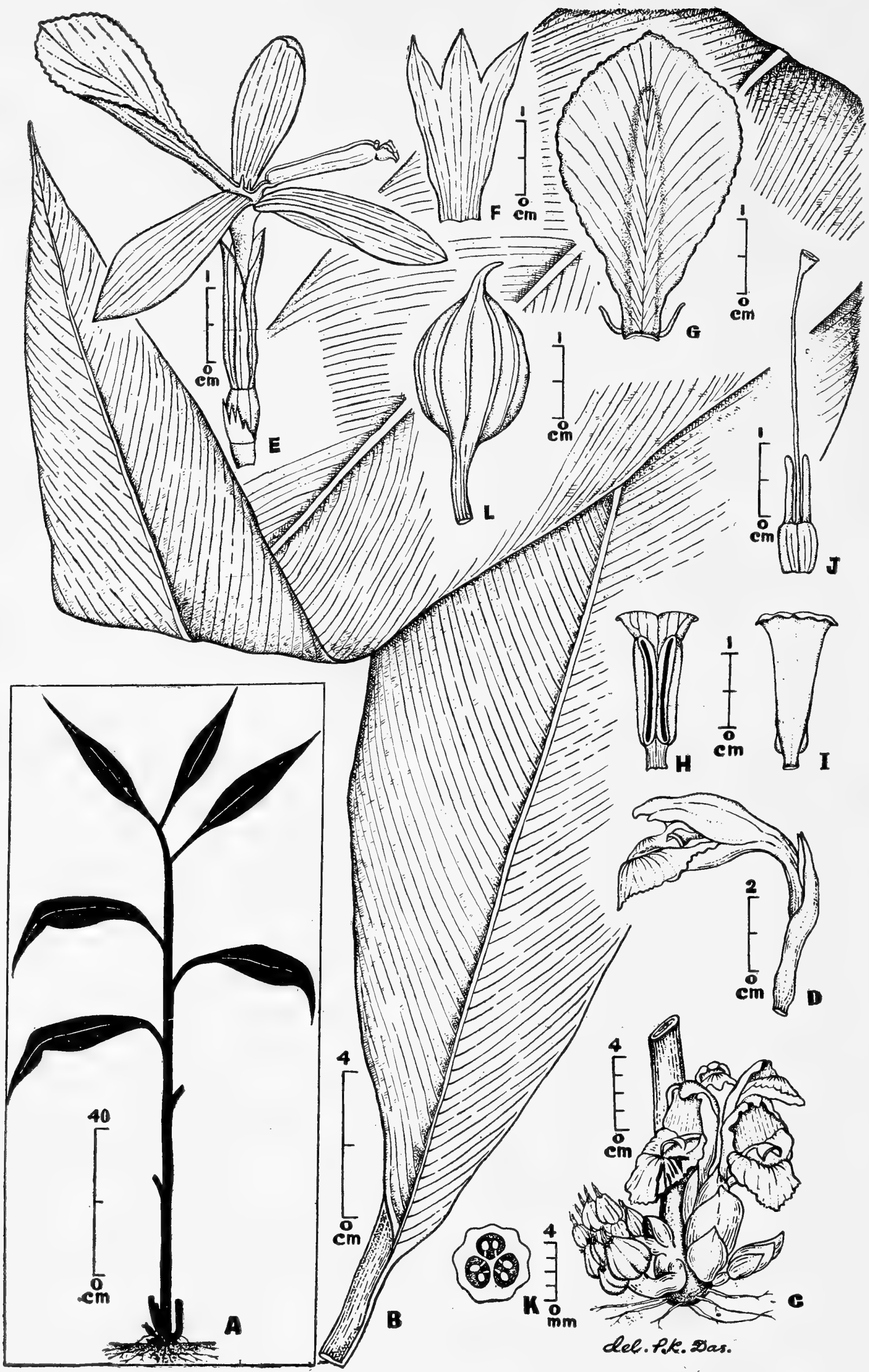
2. **A. aculeatum** Roxb. Asiat. Res. 11: 344, t. 6. 1810 et. Fl. Ind. 1: 40. 1820; Baker in Hook. f. Fl. Brit. Ind. 6: 242. 1892; Holtt. in Gard. Bull. Sing. 13: 212. 1950; Backer & Bakh. f. Fl. Java 3 :54. 1968. *A. flavum* Rdl. in J. Str. Br. Roy. As. Soc. 32: 133. 1909 et Fl. Mal. Pen. 4: 263. 1924. (Plate I).

Plants 2.5-3.5 m high; rhizome branched, yellowish-brown; stems 2.5-3.5 cm thick, reddish at base; leaves appearing with flowers, distichous, elliptic, lanceolate, cuneate at base, acuminate at apex, 40-60 cm long, 7-12 cm broad, glabrous; petiole short; ligule ± 1 cm long, subentire to bifid. *Inflorescences* many, arising from rhizome; peduncles 12-22 cm long, 1.0-1.5 cm thick; sterile bracts many, spirally arranged, closely sheathing, ovate, cuspidate, 4.0-5.5 cm long, 2.5-3.5 cm broad, red; spikes oblong, 7-15 cm long, 4-7 cm thick; floral bracts ovate, boat-shaped, slightly notched at apex, 4.5-5.5 cm long, 2.0-2.5 cm wide, reddish purple; bracteole tubular, 1.2-1.4 cm long, pinkish purple; oblique and minutely incised at mouth, puberulous on keel; pedicels 2-3 mm long, 4-5 mm thick. *Calyx* tubular, 2.5-3.0 cm long, 3-keeled towards apex, split for up to half way, red, puberulous on keels towards apex; limb 2-lobed, ± 5 mm long; lobes ovate. *Corolla-tube* 1.6-1.8 cm long, white; lobes 3; lateral lobes elliptic-oblong, obtuse to subacute, 2.5-2.8 cm long, 1.0-1.2 cm broad; median lobe obovate, obtuse, boat-shaped, 2.5-3.0 cm long, 2.5-3.0 cm broad. *Labellum* wedgeshaped, undulate-crispate at margin, 3.5-4.0 cm long, 3.8-4.2 cm broad, white with thick yellow red-striated median band, trilobed at apex; lateral lobes rounded, ± 1.5 × 2 cm, hyaline; median lobe triangular, obtuse, subacute, sometimes bilobed, 6-8 mm long, 8-10 mm wide, hyaline, white with two thick yellow spots at middle. *Staminodes* 2, fixed at the base of lip, linear-subulate, 4-5 mm long. *Anther* oblong, 1.0-1.3 cm long, 5-6 mm broad, puberulous; crest 5-6 mm long, 1.5-1.7 cm broad, 3-lobed, white; lateral lobes orbicular, 5-7 mm long, 4-5 mm broad; median lobes truncate, rounded or irregularly cre-



Amomum aculeatum Roxb.

Fig. A. habit; B. rootstock with rhizomes and inflorescence; C. leaves; D. flower with bract; E. bracteole; F. calyx; G. corolla; H. lip; I. stamen, inner view; J. stamen, outer view; K. ovary with style and stylodes; L. t.s. of ovary.



Amomum maximum Roxb.

Fig. A. habit; B. leaf; C. rootstock with inflorescence and infrutescence; D. flower with bract; E. flower spread out, bract removed; F. calyx; G. lip; H. stamen, inner view; I. stamen, outer view; J. ovary with style and stylodes; K. t.s. of ovary; L. fruit.

nate at apex, 3-5 mm long, 3-4 mm broad; filament linear, flat, 1.2-1.4 cm long, 3-4 mm broad, glabrous. *Ovary* 4-5 mm long, 3-4 mm thick, puberulous, pink; ovules numerous; style filiform, 4.2-4.5 cm long, puberulous; stigma cup-shaped, dorsoventrally compressed, ± 1 mm long, ± 2 mm broad, puberulous. *Stylodes* fleshy, cream-coloured, 2-3 mm long, many-lobed.

SOUTH ANDAMAN ISLAND: Ferrargunj-Miletilak, ± 50 m, 15 May 1976, *N. G. Nair* 3752.

Distribution: S. Andamans, Malaysia and Java.

The present specimens differ from true *A. aculeatum* in the smaller midlobe of labellum and in the white colour of the lip. However these differences seems to be of minor importance as they agree with *A. aculeatum* Roxb. in most major features.

3. **A. maximum** Roxb. Fl. Ind. 1: 41. 1820; Backer & Bakh. f. Fl. Java 3: 54. 1968. (Plate II).

Plants 2-3 m high; rhizome branched, yellowish-green; stems 3-5 cm thick at base; leaves appearing with flowers, distichous, broadly oblong-elliptic, cuneate at base, acuminate at apex, 50-70 cm long, 12-18 cm broad, dark green above, pale pubescent beneath; petioles 5-8 cm long. ligules ± 3 cm long, entire to 2 fid, *Inflorescences* several, crowded basally at ground level, arising from rhizome, appearing with and near base of leafy stem, ovoid; peduncles 10-15 cm long, 1.0-1.5 cm thick; sterile bracts several, spirally arranged, closely sheathing, ovate, mucronate, 5-8 cm long, 2.5-5.0 cm broad, white, tinged red; floral bracts becoming slimy and disappearing before anthesis, white; bracteole absent; pedicels 4-5 mm long, 2-3 mm thick. *Calyx* enclosing ovary, 2-3 cm long, thinly hyaline with 3 triangular lobes. *Corolla-tube* 2.3-2.5 cm long, white; lobes 3, oblanceolate to obovate, subacute, 2.3-2.8 cm long, 0.8-1.2 cm broad, white. *Labellum* elliptic-obovate, 3. 0-3.5 cm long, 1.6-1.9 cm broad, longer than corolla lobes, entire, undulate crispate at margin, white, with thick yellow red-speckled median band; claw ± 2 mm long, reddish above. *Staminodes* 2, subulate, ± 2 mm long, inserted at base of lip. *Anther* 1.3-1.5 cm long, glabrous with connective prolonged into a crest; crest truncate, broad at apex, split or emarginate at middle, recurved at margin, 2-3 mm long, 8-10 mm broad, white, nerved; filament flat, 2-3 mm long, ± 2 mm broad, white, scattered glandular-hairy. *Ovary* drum-shaped, angular, 5-6 mm long, 4-5 mm thick, 3-celled, glabrous; ovules numerous; style filiform, white, lying between anther cells, 3.3-3.5 cm long; stigma widened at apex, cup-shaped, compressed dorsoventrally, ± 1.5 mm across, ciliolate at margins. *Stylodes* 2, free, on both sides of stylar bases, semicylindrical, obtuse, 7-8 mm long, yellowish. *Fruits* in dense heads, ovoid, 2.5-3.0 cm long, 2.0-2.5 cm thick, aromatic, longitudinally 9-winged; wings imperfectly irregularly toothed.

SOUTH ANDAMAN ISLAND: Ferrargunj-Miletilak, ± 50 m, 15 May 1976, *N. G. Nair* 3751.

Distribution: S. Andamans and Java (?).

ACKNOWLEDGEMENTS

We are grateful to Mr. B. L. Burtt and Miss R. M. Smith of Edinburgh Herbarium for studying the descriptions and illustrations of *A. aculeatum* Roxb. and *A. maximum* Roxb. and for their opinion.

BOTANICAL SURVEY OF INDIA,
ANDAMAN AND NICOBAR CIRCLE,
PORT BLAIR, ANDAMAN,
August 31, 1977.

N. P. BALAKRISHNAN
N. G. NAIR

26. RECORD OF *HYPTIS CAPITATA* JACQ. (LABIATAE) FROM PENINSULAR INDIA

(*With a text-figure*)

Hyptis capitata Jacq. in Coll. i. 102. Ic. Rav. I. t. 114. 1786; Prain in Bengal Plants 633.1903 (reptd. 1963); Mukerjee in Rec. Bot. Surv. India 14(1): 63.1940.

The collection of this interesting Labiatae (Lamiaceae) from Kottayam, Kottayam District, Kerala State (Kept at MH) records its occurrence for the first time from Peninsular India. Hitherto it has been recorded from lower Bengal and Andaman Islands. Prain (1903) and Mukerjee (1940) have dealt with this plant in detail. As the plant is poorly known in Peninsular India and is an exotic, introduced from America, it is thought that an illustrated (*see* text-fig. on p. 201) description will be of use.

Herbs, reaching about 3 m height; branches quadrangular, pubescent. Leaves 10-15 × 5-8 cm, broadly ovate-oblong, hairy, apex acute, base tapering, nerves 6-8 pairs; petioles upto 5 cm long, hairy. Flowers in heads, axillary, peduncles larger than floral head; bracts ovate-lanceolate, reflexed. Sepals 5 lobed, lobes subulate, densely hairy, shorter than the tube. Petals white, larger than sepals, lobes subequal. Stamens 4, didynamous; filaments free, anther cells confluent. Disc present entire. Ovary 4-partite, bicarpellate. Style shortly bifid at tip. Nutlets 4, 2 × 1 mm, ovoid, smooth, not winged, basal scar small.

ACKNOWLEDGEMENT

I wish to express my sincere thanks to Dr. J. Joseph, Regional Botanist, Botanical Survery of India, Coimbatore, for help and suggestions.

T. G. VARGHESE

LECTURER,
C. M. S. COLLEGE,
KOTTAYAM,
KERALA STATE,
November 2, 1977.

REFERENCES

MUKERJEE, S. K. (1940): A revision of the Labiatae of the Indian Empire. *Rec. Bot. Surv. India 14* (1).

PRAIN, D. (1903): Bengal Plants. (reprint 1963).

27. A NEW DISTRIBUTIONAL RECORD FOR *DISTEMON INDICUM* WEDD. FROM TEHRI GARHWAL

Distemon indicum Wedd. Monogr. Urt. 551, t. 20. 1856, J. D. Hooker in Fl. Brit. Ind. 5: 588, 1888, *D. grossum* Wedd. in DC. Prodr. 16, 1: 235, 1869.

A slender annual herb. Leaves alternate, petioled; toothed. Stem 60-90 cm. Flowers monoecious in small bracteate 3-fid, androgynous clusters which form long terminal spikes. Bracts broadly ovate, acuminate concave. Male flowers minute tipped with hooked hairs,

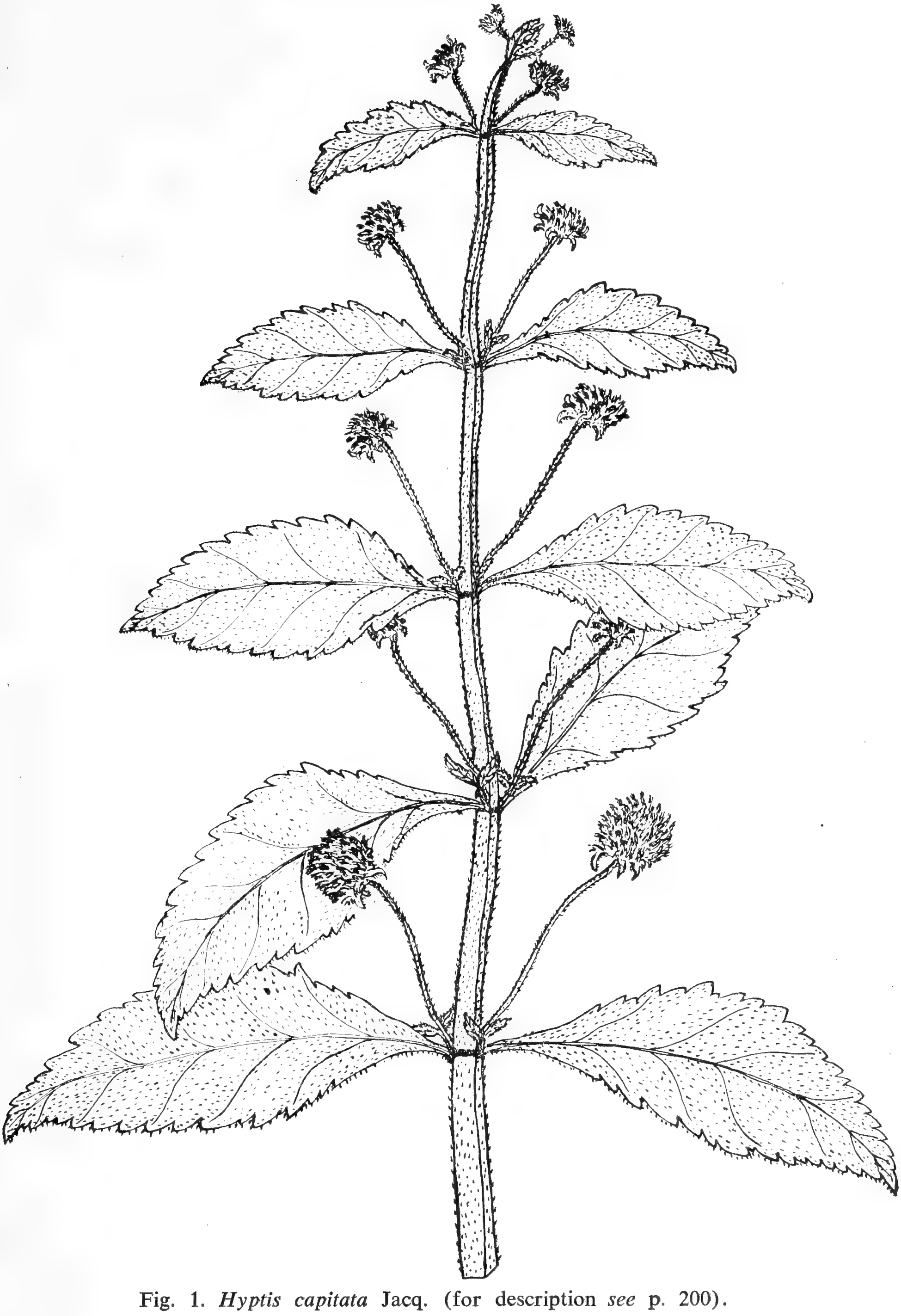


Fig. 1. *Hyptis capitata* Jacq. (for description *see* p. 200).

female strigose. Achene broadly ovoid, beaked.

I recently surveyed the area of Tehri Garhwal and observed this species growing as an undergrowth of *Adhatoda zeylanica* Medic. (Date 28.iii.76, Dhyani 278). Further the distribution of the taxon is not widespread and its migration to the area seems to be recent. This species has been collected for the first time from south Garhwal. The plant was reported by M. B. Raizada in 1939 from Dehra Dun (Ind. For. Reco. (n.s.) Bot. 1 : 5, 1939).

I acknowledge my sincere gratidue to Prof. S. D. Sharma.

SHIV KUMAR DHYANI

BOTANY DEPARTMENT,
D. A. V. P. V. COLLEGE,
DEHRA DUN,
August 17, 1977.

28. ON THE OCCURRENCE OF *GYMNEMA CUSPIDATUM* (THUNB.) K. SCHUM. (ASCLEPIADACEAE) IN MAHARASHTRA

(*With six text-figures*)

Though Trimen (1895) noted *Gymnema cuspidatum* (Thunb.) K. Schum. as endemic to Sri Lanka, it has been subsequently collected by Woodrow (1898) from Dharwar district and over 60 years later by Santapau (1962) from Jog falls, both from Karnataka. However, except for a specimen from Sri Lanka there are no specimens in any of the Indian herbaria and apparently it is quite rare. During the recent explorations of Bhandara district, Maharashtra State, it has been recollected from Chorkamal forest.

In view of the rarity and absence of any published illustrations for the plant, a drawing of the plant (*see* tex-figures on p. 203) is given along with a brief description.

Gymnema cuspidatum (Thunb.) K. Schum. in Pfam. 4(2): 284, 1895, Sant. in *Univ. Bombay Bot.* Mem. No. 4: 50, 1962. *Gymnema pergylarioides* (Thw.) Wt. & Gard. ex Hook. f. in FBI. 4: 32, 1883, Woodrow in J. Bombay nat. Hist. Soc. 5(12): 167, 1898.

Twining undershrub. Leaves acuminate at the apex rounded at the base. Cymes umbellate, peduncles 1-2 cm. arising from between the petioles. Calyx lobes glandular within, lobes 2.5 × 1.5 cm. Corona of 5 double villous ridges, adnate to the lower half of the corolla tube. Gymnostegium 3-5 mm. Ovary glabrous-follicles 5-7 cm., cylindrical, tapering to a sharp point.

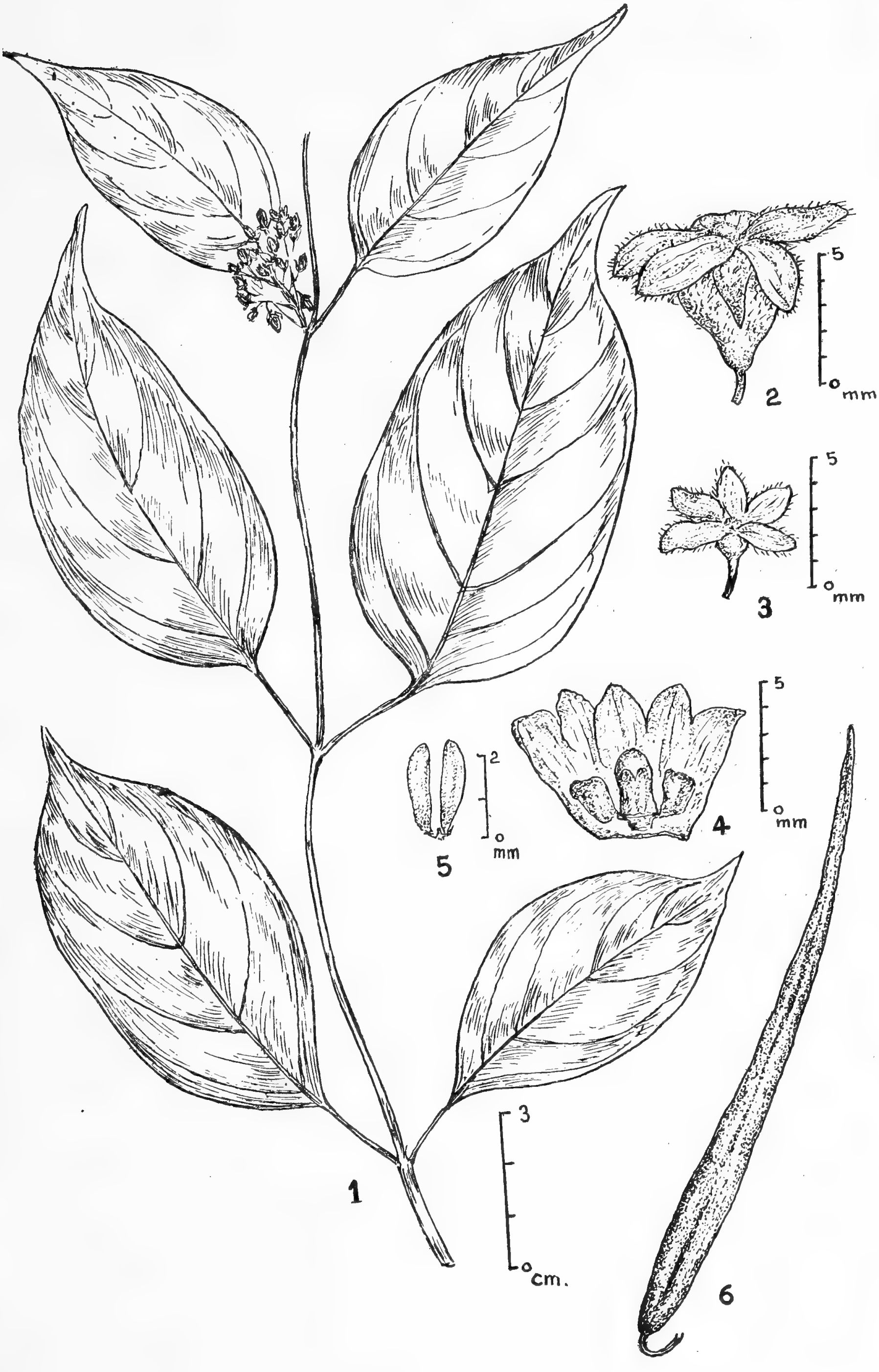
Fl. & Frt.: September-October. *Loc.*: Chorkamal forest, *Malhotra* 144660.

ACKNOWLEDGEMENTS

We are thankful to the Deputy Director, and the Regional Botanist, Western Circle, Botanical Survey of India, Poona for facilities.

S. K. MALHOTRA
K. MADHUSUDAN RAO
B. G. KULKARNI

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE,
POONA-411 001,
August 22, 1977.



Figs. 1-6. *Gymnema cuspidatum* (Thunb.) K. Schum.: 1. Flowering branch; 2. Flower; 3. Calyx; 4. Cross section of corolla; 5. Pollinia; 6. Follicle. (For description *see* p. 202).

29. AN INTERESTING GRASS FROM MAHARASHTRA

(*With twelve text-figures*)

Raizada & Jain (1957) recognised 3 species of *Eremopogon* (Hack.) Stapf namely *E. foveolatus* (Del.) Stapf, *E. strictus* (Roxb.) Camus & *E. tuberculatus* (Hack.) Camus, all of which are found in India, the latter two being endemic. However, Bor (1960) has synonymised *E. strictus* (Roxb.) Camus with *E. foveolatus* (Del.) Stapf, and recognised only 2 species under the genus. He stated that *E. tuberculatus* (Hack.) Camus is endemic in Madhya Pradesh and that it is a raerly collected.

Recently an interesting grass was collected from Dhulia district in Maharashtra which on critical examination and on matching with Duthie's specimens 8465 & 10595 mentioned in Bor's exsiccata, turned out to be *E. tuberculatus* (Hack.) Camus. So far this species was considered to be endemic in Madhya Pradesh from the adjoining districts of Betul, Khandawa & Asirgarh (Nimar district) (Hooker 1896; Bor 1960; Maheshwari 1961) and therefore, its occurrence in Maharashtra is of phytogeographical interest, as this extends the distribution of this endemic grass in Madhya Pradesh to further south in Maharashtra as well and suggests the possibility of its occurrence in the other neighbouring districts too.

The species can be easily differentiated from the other species of genus *Eremopogon* (Hack.) Stapf by its lower glume of sessile spikelet being tuberculate at keels and nerves and not pitted.

Eremopogon tuberculatus (Hack.) Camus in Ann. Soc. Linn. Lyon. 68: 207, 1921; Raizada & Jain in J. Bombay nat. Hist. Soc. 54 (4): 858-865, 1957; Bor, Grasses of Burma, Ceylon, India & Pakistan 149, 1960; Maheshwari in J. Bombay nat. Hist. Soc. 58(1): 213, 1961. *Andropogon tubercultus* Hack. in DC. Monog. Androp. 6: 404, 1889; Hooker f. Fl. Br. India 7: 168, 1896.

Specimen examined: Laling Kuran, near Dhulia, District Dhulia, *Pataskar* 118364 (8-10-1969) deposited in the regional herbarium of the Western Circle, Botanical Survey of India, Poona (*BSI*).

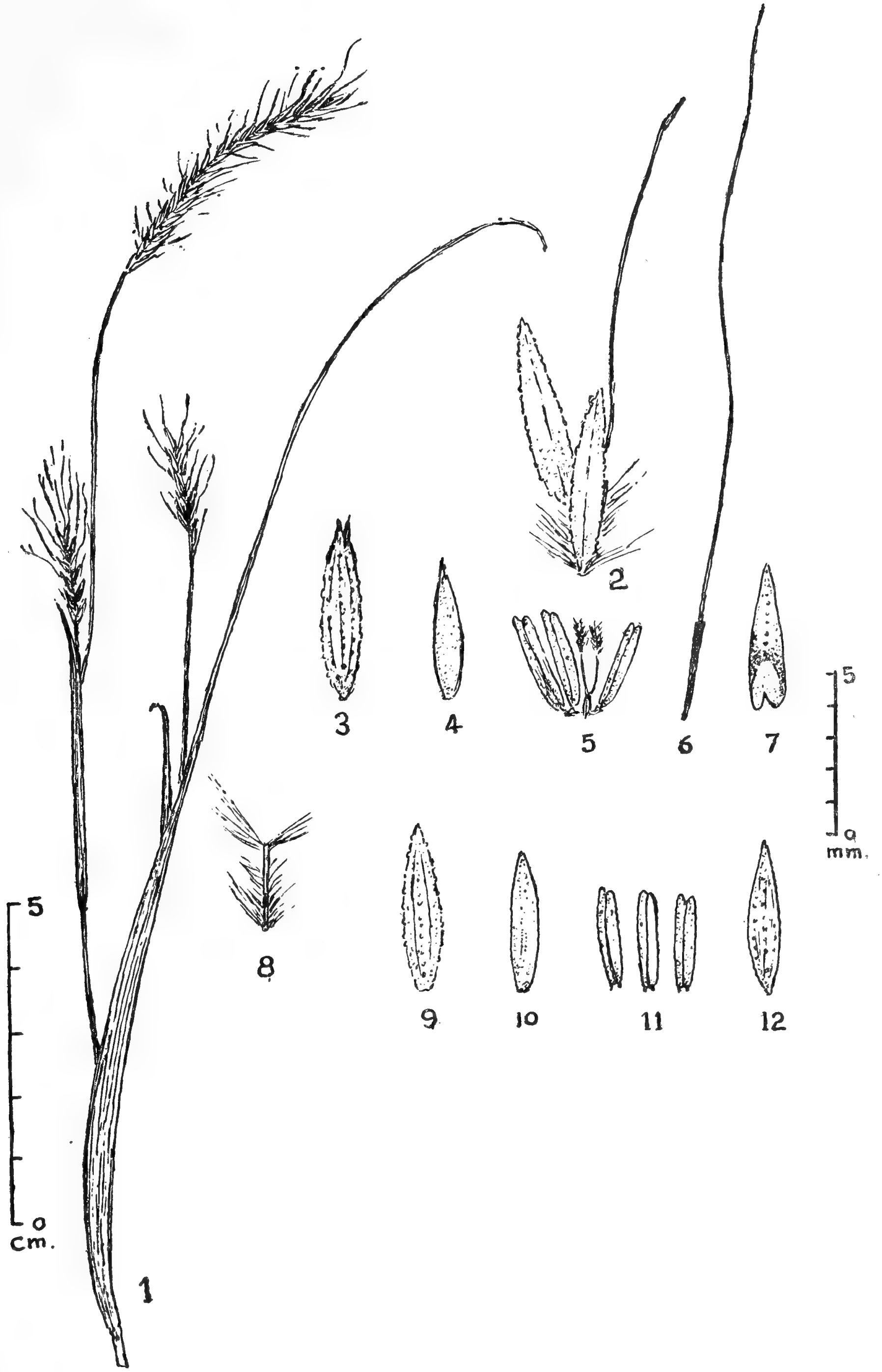
A general sketch (*see* p. 205) along with the dissection drawings is provided for facilitating easy identification.

ACKNOWELEDGEMENTS

We are thankful to the Director, Botanical Survey of India, Howrah for facilities; to the Regional Botanist, Western Circle, Botanical Survey of India, Poona for encouragement; and to the Forest Botanist, Systematic Botany Branch, Forest Research Institute, Dehradun for kindly supplying the two Duthie's sheets on loan for the study.

U. R. DESHPANDE
N. P. SINGH

BOTANICAL SURVEY OF INDIA,
WESTERN CIRCLE,
7 KOREGAON ROAD,
POONA-411 001,
July 18, 1977.



Figs. 1-2. *Eremopogon tuberculatus* (Hack.) Camus: 1. Upper portion of culm; 2. A pair of sessile & pedicelled spikelet; 3-7. Sessile spikelet: 3. Lower glume; 4. Lower lemma; 5. Stamens & pistil; 6. Upper lemma; 7. Upper glume; 8-12. Pedicelled spikelet: 8. Pedicel; 9., Lower glume; 10. Lemma; 11. Stamens; 12. Upper glume. (For description *see* p. 204).

30. SOME INTERESTING PLANT RECORDS FOR RAJASTHAN

During botanical exploration of Banswara district, southern Rajasthan, I collected 16 species of angiosperms, belonging to 16 genera and 13 families, which have not been recorded from any locality in Rajasthan by earlier workers (Blatter & Hallberg 1918-21; Puri *et al*. 1964; Vyas 1967; Ramdeo 1969; Majumdar 1971; Singh 1974). Most of these species are common in Gujarat, Madhya Pradesh, Maharashtra and Gangetic plains. The species are enumerated below with their field numbers, short diagnostic features, affinities with other related taxa, flowering and fruiting time, habitat with exact locality of occurrence and frequency and abundance in the area.

The specimens are deposited in the herbarium of Botanical Survey of India, Jodhpur (BSJO) and Central National Herbarium, Howrah (CAL).

LEEACEAE

Leea edgeworthii Santapau (2929).

Annual herbs. Leaves unipinnate or lower ones bipinnate; leaflets with close parallel veins. Flowers greenish, in dichotomous cymes. Berries purple when ripe. *Fl. & Fr.*: August-October.

Common in shady localities in the forests; abundant in Puna pathar forest block (Alt. 950 ft.). Mature berries are eaten by the local people.

PAPILIONACEAE

Clitoria biflora Dalz. (2972).

Erect, annual herbs. Leaves pinnate; leaflets 5. Flowers blue-violet, axillary, solitary or rarely geminate, deflexed. Pods flat, 3-4.5 cm. long, deflexed. *Fl. & Fr.*: August-October.

Common under bushes and shrubs in the forests, particularly in Anand Sagar forest block (Alt. 575 ft.).

Desmodium spirale (Sw.) DC. (3676).

Erect, annual herbs. Leaves 3-foliolate. Pods flat, indented very deeply on both the sutures; segments rhomboid, with strongly involute and revolute margins thus giving the pods a spirally twisted appearance. *Fl. & Fr.*: August-October.

Common in shady localities on the hills, particularly in Hura Bowji forest block (700 ft.) in association with *D. dichotomum* (Willd.) DC. which it also resembles in vegetative stage. Recently, Maheshwari & Sharma (1969) reported *D. neomexicanum* A. Gray, a native of America, from Ajmer and Mt. Abu. It differs from *D. spirale* (Sw.) DC. only in that the margins of pod-segments are sinuate, not spirally twisted.

Galactia villosa Wt. & Arn. (2974).

Herbaceous or semi-woody climbers. Leaflets 3, eglandular. Nodes of racemes tumid. Stamens didynamous (9 + 1). Style beardless. *Fl. & Fr.*: July-September.

Common among bushes and shrubs in Anand Sagar forest block (Alt. *c*. 180 m). It is sometimes confused with *Teramnus labialis* Spreng.

RUBIACEAE

Knoxia sumatrensis (Retz.) DC. (2983).

Annual herbs, upto 60 cm. high. Leaves elliptic to ovate-lanceolate. Stipules bristly, often connate into a sheath. Flowers violet-purple, 4-merous, sub-spicate on the branches of corymbose cymes. Cocci 1-seeded. *Fl. & Fr.*: August-October.

Common among grasses in wastelands near Forest rest house, Danpur (Alt. *c*. 300 m.).

Asclepiadaceae

Holostemma annulare (Roxb.) Schum. (3082).

Annual climbers. Leaves ovate-cordate. Flowers white, in axillary cymes. Anthers with membranous appendages and one pendulous pollen mass in each cell. *Fl.* & *Fr.*: August-October.

Rare; A climber on trees in Shergarh forest block (Alt. *c.* 280 m.). It resembles closely species of *Mardenia* R. Br. and *Dragea* Meyer.

Tylophora hirsuta (Wall.) Wight (2927).

Twiners, with hirsute stem, penduncles, pedicels and calyx. Leaves ovate or ovate-lanceolate, almost glabrous. Flowers pale-green, in distant, few-flowered, umbellate cymes. Coronal lobes wholly adnate to the staminal column. Follicles paired, glabrous. *Fl.* & *Fr.*: August-October.

It is a Himalayan element; common on the hills in Puna Pathar and Hura Bowji forest blocks (Alt. *c.* 300 m.). It is sometimes confused with *T. dalzellii* Hook. f. or *T. mollissima* Wight.

Loganiaceae

Cynoctonum mitreola (L.) Britt. (3675).

Erect, annual herbs. Leaves ovate, acute. Stipules broadly deltoid, often connate and reduced into a transverse ridge. Flowers white, unilateral in dichotomous cymes. Bracts and bracteoles linear, persistent. Capsules wedge-shaped, 2-horned; horns incurved. Seeds ellipsoid, 3-gonous, with a ventral cavity. *Fl.* & *Fr.*: August-November.

Common in wet and shady localities in Puna Pathar forest block (Alt. 700 ft.). It resembles closely species of *Ophiorrhiza* L. (Rubiaceae).

Gentianaceae

Canscora decussata Roem. & Schult. (3690).

Erect, annual herbs. Leaves 3-nerved. Stem, pedicels and calyx distinctly winged. Flowers white. Capsules membranous. *Fl.* & *Fr.*: August-October.

Common in wet and shady localities in Wadita village forest block (Alt. 650 ft.).

Acanthaceae

Neuracanthus sphaerostachyus (Nees) Dalz. (3010).

Erect, semi-woody herbs. Flowers violet-purple, in dense, spherical or globular, axillary, bracteate spikes. *Fl.* & *Fr.*: August-October.

This species is apparently endemic in Western Peninsula. Present collections from shady localities on the steep slopes and foot of hills in Loharia forest block (Alt. 500 ft.) extend its distribution further northwards. The number of viable seeds per plant is few. Dalzell (1850) and Santapau (1951) have given contradictory remarks in this regard.

Labiatae

Leucas zeylanica R. Br. (3067).

Erect, annual, hispid herbs. Leaves linear, less than 1.5 cm. broad. Calyx-mouth oblique, produced above, villous within. Nutlets obovoid-oblong, sharply angular on the inner face. *Fl.* & *Fr.*: August-October.

Common weed of cultivated fields in the western part of the district, particularly near Shergarh village (Alt. *c.* 250 m.).

Amaranthaceae

Amaranthus caudatus Linn. (3020).

Annual, glabrous herbs. Leaves obtuse. Bracts straight, not much exceeding the obovate, mucronate sepals. *Fl.* & *Fr.*: August-October.

Occasional; found in humus rich fertile soils near habitations (Banswara; Alt. *c.* 300 m.).

ZINGIBERACEAE

Curcuma pseudomontana Grah. (2860).

Tubers elliptic or globose, yellow inside, borne at the end of root-fibres. Corolla yellow, covered within greenish bracts tinged with red or purple. The position of the spike in relation to the leaves is at first lateral. Later on, in the rainy season, this lateral spike decays and gives way to a central one. Most of the flowers are infested by some insects (*see* Santapau 1945, 1952; Chavan & Oza, 1966). *Fl. & Fr.*: July-October.

Common in the forests; abundant on Dagia Bowji hill near Ghatol (Alt. *c.* 210 m.).

DIOSCOREACEAE

Dioscorea hispida Dennst. var. **daemona** (Roxb.) Prain & Burk. (3083).

Extensive woody climbers, often bearing bulbils on the nodes. Leaves 3-foliolate. Male flowers closely packed. Fertile anthers 6. Seeds winged on one side only. *Fl. & Fr.*: August-November.

Rare; found in the dense forests of Shergarh block (Alt. *c.* 280 m.). Roxburgh (1832) says that the tuberous roots are dreadfully nauseous, even after being boiled.

CYPERACEAE

Cyperus meeboldii Kuk. (3034).

An erect sedge, upto 25 cm. high, with a small pseudo-bulbous base. Spikelets elliptic, $4\text{-}6 \times 1.5\text{-}2.5$ mm., condensed in solitary, terminal heads about 1 cm. in diameter, subtended by 3, unequal, leafy bracts. Glumes boat-shaped, mucronate, 5-nerved, 2 mm. long. Anther one. Style slender, without stigmatic lobes. Achenes 3-gonous, turbinate, about 0.5 mm long.

Common in open wastelands near Forest Nursary, Kushalgarh (Alt. *c.* 280 m.), in association with *C. triceps* (Rottb.) Endl. This is a peninsular species reported so far from Badami (Mysore) in India (*see* Fedde Report. 18: 347. 1922). Hooper and Napper (1972) also mentioned its occurrence in Peninsular India. The recent collections also from Kailana (*Moorthy* 83 BSJO), Mandor (*Tiwari* 615b BSJO) and Sardarpura, Pali (*Shetty* 1843 BSJO) extend its distribution further northwards.

GRAMINEAE

Panicum psilopodium Trin. var. **psilopodium** (3086).

Annual, glabrous grass. Panicles effuse. Spikelets ovate-oblong to elliptic, 2-3 mm. long, symmetrical, not gaping. *Fl. & Fr.*: August-September.

Common near water in Shergarh forest block (Alt. *c.* 280 m.). Variety *coloratum* Hook. f. occurs on Mt. Abu (Bor 1960).

V. SINGH

ARID ZONE CIRCLE,
BOTANICAL SURVEY OF INDIA,
JODHPUR,
November 1, 1977.

REFERENCES

BLATTER, E. & HALLBERG, F. (1918-21): The Flora of the Indian desert. *J. Bombay nat. Hist. Soc. 26-27*: on different pages.

CHAVAN, A. R. & OZA, G. M. (1966): The Flora of Pavagarh (Gujarat). *Mahar. Sayajir, Univ. Boroda (Bot. Mem.). 1*: 222-223.

DALZELL, N. A. (1850): Contribution to the Botany of Western India. *Kew Jour. Bot. 2*: 140.

HOOPER, S. S. & NAPPER, D. M. (1972): Cyperaceae in the Flora of West Tropical Africa. Vol. 3. London.

MAHESHWARI, J. K. & SHARMA, V. S. (1969): Some interesting plants from Upper Gangetic plain. *Bull. bot. Surv. Ind. 11* (3-4): 454-456.

MAJUMDAR, R. B. (1971): Synoptic Flora of Kota division (S. E. Rajasthan.). *Bull. bot. Surv. Ind. 13* (1-2): 105-145.

PURI, G. S. *et al.* (1964): Flora of Rajasthan. *Rec. Bot. Surv. Ind. 19*: 1-154.

RAMDEO, K. D., (1969): Contribution to the Flora of Udaipur. Swadeshi Printer's, Udaipur.

BOR, N. L. (1960): The grasses of Burma, Ceylon, India and Pakistan. London.

ROXBURGH, W. (1832): Flora India. Vol. 3. Serampore.

SANTAPAU, H. (1945): *Curcuma pseudomontana* Grah. *J. Bombay nat. Hist. Soc. 45*: 618-624.

——— (1951): Acanthaceae of Bombay. *Univ. Bombay Bot. Mem. 2*: 65-67.

——— (1952): On a common species of *Curcuma* of Bombay and Salsette Islands. *J. Bombay nat. Hist. Soc. 51*(1): 135-139.

SINGH, V. (1974): Floristic studies on south-eastern plateau of Rajasthan. *Ph. D. Thesis, Meerut Univ.*, Meerut.

VYAS, L. N. (1967): Contribution to the Flora of north-east Rajasthan. *J. Bombay nat. Hist. Soc. 64*(2): 191-231.

31. SOME NEW PLANT RECORDS OF NAGPUR REGION

The present paper, records four new plants from Navegaon, about 135 Km., east of Nagpur in Bhandara District. These are:

COMBRETACEAE

Combretum ovalifolium, Roxb. Hort. Beng. 1814. Fl. Ind. ii 256. *C. heyneanum*, Wall. Cat. 4001. *C. roxburghii* and *C. albidum*, G. Don.

A large scandent shrub; leaves opposite ovate; racemes lateral and terminal; flowers sessile; fruit pale golden brown with four papery finely transversely striate wings. Flowers—Nov.-Dec. Fruiting—Jan.-Feb. Common plant. *Munshi* 1.

APOCYNACEAE

Ellertonia rheedii, Wight, Incon. 1850. t. 1295. F.B.I. iii 641.

Climbing glabrous shrub, branches twinning, slender; leaves opposite, elliptic-oblong, acuminate, glabrous; flowers in di-or trichotomously branched cymes; bracts small, acute, persistent; folicles 5-15 cm. long, cylindric, divaricate, slightly recurved. Flowers—Nov-Jan. Fruiting—Jan-March.
Common. *Munshi* 2.

LABIATAE

Dysophylla cruciata, Benth. in Wall. Pl. As. Rar. Vol. I. 1830. Cat. 1541. *D. tetraphylla*, Wight Ic. t. 1444. *Mentha quadrifolia*, Don Prodr. 113.

Hirsute, stem simple, erect; leaves four in a whorl, sessile, linear, margins revolute quite entire; spikes single, dense; flowers pale purple; calyx villous; corolla tube entire or sparingly glabrous.

Flowers—Dec.-Feb. Common near wet places.
Munshi 3.

ALISMACEAE

Tenagocharia latifolia, (D. Don). Butchen. Adh. 1868. *Butomus latifolius,* D .Don, Prodr. 1825. *Butomopsis lanceolata,* Kunth, Enum. 1841, F.B.I. 6 : 562, 1893.

Marsh plant leaves elliptic-lanceolate, acute at both ends; petioles dilated at the base; pedicels long, petals white.

Flowers—Nov.-Jan. Not common. *Munshi* 4.

INSTITUTE OF SCIENCE,
NAGPUR,
November 2, 1977.

S .A. PARADKAR
S. K. MUNSHI

32. NOTES ON TWO INTERESTING SEDGES FROM GUJARAT STATE, INDIA

(*With a plate*)

After critically going through all the literature available to us on the flora of western India we find that the following two sedges have not been reported from any locality in Gujarat and probably Maharashtra State.

Lipocarpha argentea R. Br. in Tuckey, Cong 477, 1818; C. B. Clarke in Fl. Brit. Ind. 6 : 667, 1894; Fischer in Fl. Madras (reprinted ed.) 3 : 1158, 1957; Haines, Bot. Bih. & Oris. 3 : 973, 1961 (reprinted ed.); Prain, Beng. Pl. 2 : 871, 1963 (reprinted ed.).

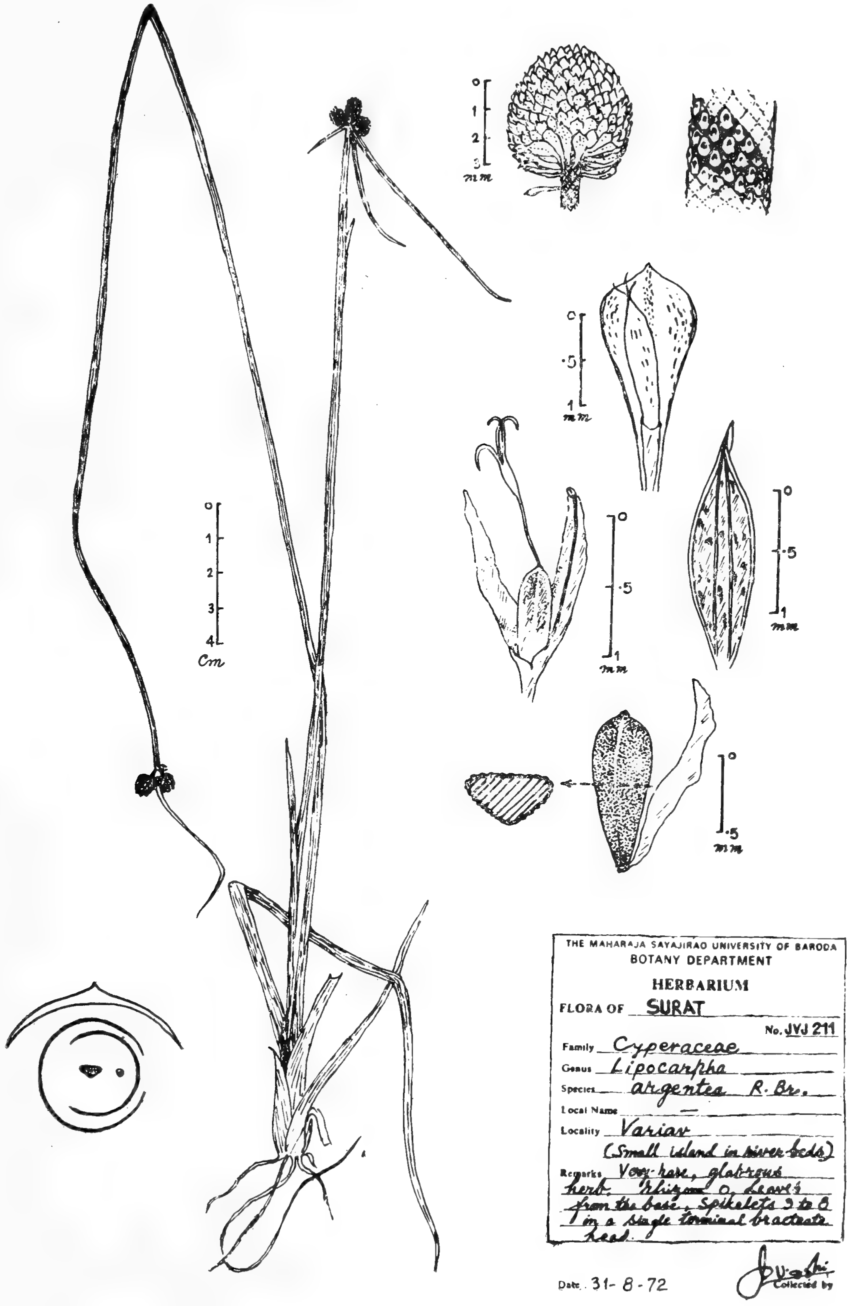
A glabrous erect herb, 40-60 cm tall; rhizome 0. Stems tufted, obtusely triangular, smooth. Leaves all basal, upto 25 cm long. Spikelets 3-8, in a terminal capitate head, white or straw coloured. Bracts 3, 0.7-8.4 mm in length. Glumes hyaline dotted and streaked with red-brown tinge, spirally arranged, obovate, apex obtusely triangular, incurved, 2-2.5 mm long deciduous from the base of persistent rhachilla marked by lozenge-shaped scars. Squamellae 2, 1.00-1.06 mm long, hyaline with a purple tinge, elliptic, inner completely imbricated by outer, each marked by four vertical prominent ribs. Stamen 1, anther very small, filament closely appressed to the inner squamella. Style 0.5 mm long, slender. stigmas 3, as long as the style. Nut small, 0.7-1.0 mm long, oblong or ovoid, Plano-convex, brown, usually minutely punctate.

The plants were collected from alluvial sandy soil on a small island in the bed of river Tapti near Variav about 9 km northwest of Surat. The plants were associated with species of *Cyperus* and *Fimbristylis.*

Flowering and Fruiting—August-September. JVJ 211 herbarium, The M. S. University of Baroda (BARO).

Distribution: Western Himalayas upto 6000 ft, Assam, Karnataka, Wynaad, Nilgiri and Palni Hills 3000-7000 ft, Sri Lanka, Singapore. Tropical and sub-tropical old world.

The Sedge in its general appearance resembles *Cyperus triceps* (Rottb.) Endl. (*Kyllinga triceps* Rottb.). This fact has also been emphasized by Fischer (loc. cit.). It is therefore, necessary to see all the available her-



Lipocarpa argentea R. Br.

barium material of these taxa in order to clearly delineate their distributional areas.

Rhynchospora glauca Vahl, Enum. 2 : 33, 1806; C. B. Clarke in Fl. Brit. Ind. 6 : 671 & in J. Linn. Soc. 34: 90, 1898; Fischer in Fl. Madras (reprinted ed.) 3: 1160, 1957; Parabia in Contrib. Cyp. Guj. State 1 : 294-295 (Plate 50), 1974 (Ph.D. thesis, unpublished).

An annual glabrous herb, 20-30 cm tall. Stem erect, trigonous. Leaves narrow-linear from the nodes, 6-14 cm long with distinct midrib. Bracts linear-narrow, 2-3.5 mm long, shorter than panicle. Spikelets in corymbose panicles, shortly pedicelled, ellipsoid, chocolate-brown in colour; lower two glumes empty, outer first shorter than inner 1.8-2.00 mm long, ovate-oblong with a single mid nerve, slightly projecting upwards; second glume slightly longer than first, 2.5-3.1 mm long. Flowering glume larger, 5.8-6.1 mm long, slightly curved at the base, enclosing the nut, single central vein slightly projecting upwards Hypogynous bristles 6 ascendingly hispidulous, 1.8-2.1 mm long, linear, all equal, straight, shorter than nut. Stamens 2, filaments longer than nut, 3.2-3.5 mm long, projecting upwards. Style 4 mm long, base dilated, dividing from the middle, stigmas 2. Nut 2.8 mm-3.00 mm long, ovoid, oblong, biconvex, beaked by the persistent elongated style base which is marked with pinkish dots; nut chocolate-brown, marked with brown transversely wavy lines alternating with faintly transversely undulate lines.

The plants were collected from alluvial sandy soils on a small island in the bed of river Tapti near Variav about 9 km, north-west of Surat. The plants were associated with species of *Scirpus* and *Cyperus*.

Flowering and Fruiting: August-September. JVJ 210-herbarium, The M.S. University of Baroda, (BARO).

Distribution: Khasia at 4000-6500 ft, Nilgiri, Anamalai (Beddome), Palni and High Wavy (Blatter & Hallberg) Mountains 5500-7500 ft. Nepal, Sri Lanka, Warm regions of the globe.

Based on the Junior author's collection, the plant is included by Parabia (loc. cit). His description of the plant has been modified in the light of our observations. Hypogynous bristles are 6 in all the spikelets dissected by us and not 4 as reported by Parabia (loc. cit.), who uses this as a Key character to distinguish the two species of *Rhynchospora* recorded from Gujarat. Our observations tally with those of Clarke (loc. cit.) and Fischer (loc. cit.) wherein the bristle number is reported to be 5-6.

The plant is restricted to high altitude regions ranging from 1300 to 2500 m. It's occurrence on the sandy beds of a river near Surat almost at sea level is interesting.

ACKNOWLEDGEMENT

Thanks are due to Dr. M. H. Parabia, Lecturer in Botany, P. T. Sarvajanik College of Science, Surat for allowing us reference to his unpublished Ph. D. thesis.

TAXONOMY LABORATORY,
DEPARTMENT OF BOTANY,
M. S. UNIVERSITY OF BARODA,
BARODA-390 002,
August 31, 1977.

S. D. SABNIS
J. V. JOSHI

33. NEW RECORDS OF PLANTS FROM ANDAMAN AND NICOBAR ISLANDS

The vegetation of Katchal Island in Andaman and Nicobar Islands has been poorly studied. S. Kurz in his paper on "A sketch of the vegetation of Nicobar Islands" (*J. As. Soc. Beng.* 45 (3): 105-164. 1876) lists several species from Katchal island. Apart from Kurz there is no other published paper on the flora of Katchal. Since the establishment of the Regional Circle of the Botanical Survey of India at Port Blair, intensive survey of Katchal island yielded several species which are new records for Andaman and Nicobar Islands. The enumeration list includes 13 species, of which 6 species are new records for India and 7 species are new records for Andaman and Nicobar Islands.

Menispermaceae

1. **Fibraurea tinctoria** Lour. Fl. Cochinch. 2: 709. 1790; Hook. f. Fl. Brit. India 1: 98. 1872.

Woody liana; bark peeling off in flakes. Leaves alternate, ovate, entire, 9.5-16 cm long, 8-10.5 cm wide, subcoriaceous, glabrous, strongly 3-nerved; lateral nerves on midrib 2-3 pairs; petiole 5.5-8.5 cm long, swollen at base and above, longitudinally grooved. Inflorescence ± 24 cm long, usually from the old stems in paniculate racemes; flowers solitary, ± 2.5 mm long, ± 2.5 mm across, pale yellow in colour; pedicel ± 2 mm long; bract minute at the base of pedicel; bracteole minute at the base of calyx and appearing as 4th sepal; sepals 3, free, unequal, less than 1 mm across; petals 6, valvate, free, oblong, obtuse, ± 2.5 mm long, 1.5 mm wide; stamens 6; anthers sessile, arising from one point on thalamus, oblong, ± 2.5 mm long, ± 0.5 mm wide, dehiscing by terminal pore. Fruit oblong, ellipsoid, ± 3 cm long, ± 1.8 cm thick; pericarp fleshy; endocarp woody, grooved on one side; seed solitary, longitudinally grooved on one side, ± 2.5 cm long, ± 1.5 cm thick, yellow.

Katchal Island: Mildera, 29 April 1974, *Chakraborty* 1231 (PBL).

Distribution: Indo-China, Malaysia, Philippines & Borneo. A new record for India.

Violaceae

2. **Rinorea longiracemosa** (Kurz) Craib, Fl. Siam. 1: 90. 1925; Jacobs & Moore in Fl. Males. I, 7: 189. 1971. *Alsodeia longiracemosa* Kurz in J. As. Soc. Beng. 39 (2): 63. 1870.

Tree, ± 15 m tall. Leaves elliptic to oblong-lanceolate. *Racemes* slender, solitary, 8-13 cm long; flowers small, greenish white. Capsules and seeds glabrous.

Katchal Island: Kapanga, 15 April 1975, *Chakraborty* 2548 (PBL).

Distribution: Burma, Indo-China, Thailand, Malaysia, Sumatra, Java. A new record for India.

3. **Rinorea macrophylla** (Decne) O. Ktze. Rev. Gen. Pl. 1: 42. 1891; Jacobs in Blumea 15. 135. 1967; Jacobs & Moore in Fl. Males. I, 7: 190. 1971. *Alsodeia macrophylla* Decne, Ann. Mus. Hist. Nat. Paris 3: 468, t. 9. 1834. *Rinorea horsfieldii* Miq. Fl. Ind. Bat. 1, 2: 117. 1859; Backer & Bakh. f. Fl. Java. 1: 195. 1963.

Shrub, ± 2 m tall. Leaves obovate, ellipsoid-oblong, 8-20 cm long, 4-9 cm wide. Inflorescence fasciculiform, many-flowered; ovary pubescent. Capsule trigonous-globose.

Katchal Island: Mildera, 12 Nov. 76, *Chakraborty* 4659 (PBL).

Distribution: Siam, Malay peninsula, Sumatra, Java, Philippines. A new record for India.

BURSERACEAE

4. **Dacryodes rugosa** (Bl.) H. J. Lam. Jard. Bot. Btzg. 42: 203, t. 11, ff. 64. 1932; Leenhouts, in Fl. Males. I, 5: 221. 1956. *Sanitra rugosa* Bl. Mus. Bot. 1: 212. 1850.

Tree, ± 6 m. tall. Leaves compound, paripinnate, chartaecous; leaflets, 3-4 pairs, lower leaflets smaller, the upper ones larger, oblong-lanceolate, unequal at base, abruptly acuminate at apex, 8-14 cm long, 3-8 cm broad; acumen ± 1.5 cm long, ± 0.4 cm broad; midrib slightly raised above, prominent beneath; lateral nerves 13-16 pairs, slightly curved, glabrous; petiolules thickened at both ends, 1.0-1.5 mm thick. Fruiting peduncle patently pubescent; fruit an indehiscent drupe, ovoid, slightly pointed at apex, pink in colour, slightly oblique, ± 2.5 cm long, ± 2 cm thick; rugose when dry.

Katchal Island: Mildera, 29 April 1974, *Chakraborty* 1219 (PBL).

The specimens collected are in fruit and has been identified at Leiden herbarium. Detailed description of the species is given by Leenhouts (l.c.).

Distribution: Malaysia, Sumatra, W. Java and Borneo. A new record for India.

CUCURBITACEAE

5. **Cucumis callosus** (Rottl.) Cogn. in Engler, Pflanzenr. 88: 129. 1924. *Bryonia callosa* (*'collosa'*) Rottl., Neue Schrift. Gen. Nat. Freunde Zu Berlin 4: 210. 1803. *Cucumis trigonous* Roxb. Fl. Ind. 2: 722. 1824; Clarke in Hook. f. Fl. Brit. India 2: 619. 1829. (excl. syn.); Chakraborty in Ind. Journ. Agric. Sc. 16 (1): 51. 1946.

Prostrate trailing herb or climber; stem slender, angular; not much branched; tendril simple. Leaves sub-orbicular, 7-lobed, cordate at base, obtuse at apex, slightly broader than long, 2-2.8 cm long, 2.5-3.5 cm broad; petiole slender, 1.2-3.5 cm long, hispid. *Flowers* unisexual, yellow; male flowers in groups at 2-3, ± 10 mm long, ± 4 mm across; pedicels slender, ± 2.5 mm long; calyx-tube narrow, campanulate, villous, ± 3 mm long; lobes 5, subulate, ± 1.5 mm long; corolla campanulate, 5-lobed; lobes oblong-ovate, acute ± 6 mm long, ± 3 mm across; stamens 3, inserted on the calyx-tube; filament short, free; anther oblong, 5-grooved, ± 2 mm long; connective less than 1 mm long; pistillode ± 0.5 mm long. Fruit obovoid, puberulous, ± 3 cm long, ± 2.5 cm across; seeds white, oblong with acute apex, ± 4 mm long, ± 2 mm broad, less than 1 mm thick.

Katchal Island: Kapanga, 22 Aug. 1974, *Chakraborty* 2163 (PBL).

Distribution: N. Africa, Peninsular, Central and Northern India, West Bengal, Malaya, Australia, China. A new record for Andaman and Nicobar Islands.

RUBIACEAE

6. **Randia curvata** Valet. in Ic. Bogor. 2: t. 146. 1903-1906; Back & Bakh. f. Flora of Java 2: 310. 1965.

Liana; leaves ovate, ovate-oblong to elliptic; thorn deflexed; cymes terminal; fruit globose, ± 20 mm across.

Katchal Island: Hill towards jetty, E. Bay, 20 Dec. 74, *Chakraborty* 2221 (PBL).

Distribution: Java. A new record for India.

SYMPLOCCACEAE

7. **Symplocos microtricha** Hand-Mazz. in Beih. Bot. Centralbl. 62-B; 17. 1943, Nooteboom, Rev. Symplocaceae 239. 1975.

Shrub ± 2 m. tall; leaves elliptic to obovate, ± 10 cm long, 3.5 cm wide; nerves 8-10 pairs; fruit ovoid, constricted towards the apex, ± 8 mm long, ± 4 mm thick.

Katchal Island: W. Bay, in inland forests, 13 Feb. 77, *Chakraborty* 5204.

Distribution: Indo-China, China and Malay peninsula. A new record for India.

Oleaceae

8. **Myxopyrum smilacifolium** Bl. Mus. Bot. 1: 320. 1850; Kurz, For. Fl. Burma 2: 160. 1877; Clarke in Hook. f. Fl. Brit. India 3: 618. 1882.

Climber, stem quadrangular; leaves 14-18 cm long, 8-10 cm wide; inflorescence a panicle; fruit globose.

Katchal Island: Mildera, 7 May 1975, *Chakraborty* 2527 (PBL).

Distribution: Assam, Cachar, Chittagong, Pegu, Penang, Malaya. A new record for Andaman and Nicobar Islands.

Apocynaceae

9. **Hunteria corymbosa** Roxb. Fl. Ind. 1: 695. Hook. f. Fl. Brit. India, 3: 637. 1882; Ridley, Fl. Malay Peninsula 2: 335, 1923.

Tree, ± 5 m tall; leaves oblanceolate; nerves fine, 20-25 pairs; corymbs 3-5 cm long; corolla white; berries globose, beaked, yellow.

Katchal Island: Kapanga, roadside, 2 Nov. 76, *Chakraborty* 4602. (PBL).

Distribution: India, Sri Lanka, Sumatra. A new record for Andaman and Nicobar Islands.

Amaranthaceae

10. **Alternanthera sessilis** (L.) R. Br. ex R. & S. var. **tenuissima** (Suess.) Backer in Fl. Males, I, 4: 93. 1949. *Alternanthera tenuissima* Suess. in Bot. Arch. 39: 382. 1939.

Leaves from a narrowed base, filiform, shortly mucronate, 2-6 cm long, ± 0.5 cm wide.

Katchal Island: Kadao village, W. Bay, 1 May 1977, *Chakraborty* 5547 (PBL).

Distribution: Malaysia and New Guinea. A new record for India.

Zingiberaceae

11. **Zingiber aromaticum** Roxb. Fl. Ind. 1: 45, 1824, Backer in Hook. f. Fl. Brit. India, 6: 240. 1892.

Spike globose; lip pale yellow; anther crest large; capsule ± 2.5 cm long, oblong, trigonous.

Katchal Island: Kapanga, coastal, 28 August 74, *Chakraborty* 2108 (PBL).

Distribution: Sikkim, N. Bengal, Meghalaya, Bangladesh. A new record for Andaman and Nicobar Islands.

Commelinaceae

12. **Pollia sorzogonensis** (E. Meyer) Endl. Gen. Pl. 14: 1029. 1840; Hook. f. Fl. Brit. India 6: 367. 1892. *Aclisia sorzogonensis* E. Meyer in Presl. Rel. Haenk. 1: 138, t. 25. 1827.

Stem erect, viscid; leaves 15-25 cm long, shortly petioled; peduncle villous with deflexed hairs.

Katchal Island: Mildera, 10 August 74, *Chakraborty* 2023 (PBL).

Distribution: Sikkim, Bhutan, Burma, Malacca, Sri Lanka. A new record for Andaman and Nicobar Islands.

Commelinaceae

13. **Aneilema vaginatum** (L.) R. Br. Prodr. 271. 1810; Hook. f. Fl. Brit. India 4: 381. 1892. *Commelina vaginata* L. Mant. 177. 1771.

Roots fibrous; stem decumbent, rooting at nodes; flowers 1-3 pedicelled; stamens 2, fertile; staminodes 2; capsule cuspidate; seeds.

Katchal Island: Delhi village, W. Bay, 13 June 77, *Chakraborty* 6028 (PBL).

Distribution: Sri Lanka, Peninsular India, Bengal, Burma. A new record for Andaman and Nicobar Islands.

ACKNOWLEDGEMENT

I express my sincere thanks to Dr. N. P. Balakrishnan, Regional Botanist, Botanical Survey of India, Port Blair for his valuable inspiring guidance rendered to me during studies on Flora of Katchal Island.

BOTANICAL SURVEY OF INDIA,
PORT BLAIR, ANDAMANS,
September 12, 1977.

PARITOSH CHAKRABORTY

34. FILAMENTOUS MYXOPHYCEAE OF AURANGABAD DISTRICT, MAHARASHTRA

Between September 1975 and June 1977, about fifteen hundred vials of algae have been collected from a number of places in Aurangabad district in Marathwada division of Maharashtra state. The rainfall of Aurangabad district varies from 50 to 150 cm. The temperature varies from 9°C in December to 41°C in May. The pH of the water of the collection spots was determined by using B.D.H. universal indicator. The pH is mentioned in brackets immediately after the collection spots in the habitats. Camera lucida diagrams of all the algae have been drawn and preserved.

In this paper forty five taxa belonging to eleven genera of the filamentous algae have been recorded. Of these only five taxa have been earlier recorded from Aurangabad proper by Kamat (1974),[1] however, the localities mentioned by Kamat are different from the ones recorded here. The remaining forty algae are additions to the flora of Aurangabad district.

[1] KAMAT, N. D. (1974): Algae of Marathwada, Maharashtra. *Phykos 13*: 22-32.

Spirulina laxissima West, G.S.
In blue green mucilaginous masses in a tap water culture (8.5), Institute of Science Laboratory, Aurangabad (28-10-75).

Spirulina major Kuetz. ex Gomont
Blue greenish masses submerged in a stream (9.5), Aurangabad (6-11-75).

Oscillatoria annae van Goor
Greenish brown masses forming thin layers on moist soils near Harsool talao, Aurangabad (11-10-75).

Oscillatoria biswasii Kamat
Bluish green mucilaginous masses along with a thin layer of soil floating and submerged in a small pool, Aurangabad (11-10-75).

Oscillatoria chalybea (Mertens) Gomont
Abundant in a pool (8.5), Khokadpura, Aurangabad (1-10-75). In oxidation pond (9), near Kanchanwadi (19-10-75).

Trichomes are slightly narrower than those of the type.

Oscillatoria cortiana Meneghini ex Gomont v. minor Kamat
Bluish green masses adhering to the Cyperaceae members in oxidation pond (10.5) near Kanchanwadi (10-10-75).

Oscillatoria mougeotii Kuetzing
Greenish brown mass adhering to aquatic plants submerged in a temporary pool (9), Aurangabad (6-11-75). Greenish mass forming a layer on submerged rock, Kham river (9), Aurangabad (1-10-75).

Trichomes are slightly narrower than those of the type.

Oscillatoria okeni Agardh ex Gomont
Abundant bluish green masses adhering to submerged rocks in Kham river (8.7), Aurangabad (1-10-75).

Trichomes of this alga are slightly narrower than those of the type.

Oscillatoria princeps Vaucher ex Gomont
Planktonic in a river (8.5) at Farola fata (2-1-77). Bluish green mass in a stream (8.5), Aurangabad (6-11-75). Blue green mass forming a layer on sand in a stream (8.5), University campus, Aurangabad (7-11-75).

Oscillatoria profunda Kirchner
Blackish green mass adhering to the submerged grasses in a stream (8.5), Aurangabad (6-11-75).

Oscillatoria pseudogeminata G. Schmid
Blackish green mass adhering to submerged stones in a big gutter (8.5), Aurangabad (6-11-75).

Oscillatoria pseudogeminata G. Schmid f. **longa** Kamat
Brownish masses adhering to submerged rocks in Kham river (8.5), Aurangabad (1-10-75).

Oscillatoria rosea Utermohl
Greenish brown mass forming a thin layer on moist soil near Harsool talao, Aurangabad (11-10-75).

The cells are sometimes much longer.

Oscillatoria subbrevis Schmidle
Adhering to submerged grasses in a big gutter (8.5); forming a thin layer on the submerged inner wall of a cistern (8.7), Pawanchakki, Aurangabad (1-10-75).

Oscillatoria tambi Woronich
Greenish brown mass adhering to submerged stones in a big gutter (8.5), Aurangabad (6-11-75).

Phormidium anomala Rao, C.B.
Bluish green mass forming a thin layer adhering to the submerged glass of the tap water culture (8.5), Institute of Science Laboratory, Aurangabad (8-11-75).

Trichomes slightly narrower than those of the type.

Phormidium bigranulatum Gardner
Greenish blue mass forming a mucilaginous layer on the submerged stone wall of a kund (8.5), Aurangabad caves, Aurangabad (2-10-75).

Phormidium ceylanicum Wille v. **minor** Kamat
Greenish mucilaginous mass adhering to the roots of aquatic plants, Kham river (8.5), Aurangabad (3-10-75).

Phormidium favosum (Bory) Gomont
Greenish mass adhering to submerged stone slope near a big cistern (8.5), Aurangabad (1-10-75).

Phormidium henningsii Lemm.
Blackish green mass forming a mucilaginous layer on moist soil, Aurangabad (18-9-75).

Phormidium jenkelianum Schmid, G.
Brownish green mass adhering to submerged rock in Kham river (8.7), Aurangabad (1-10-75).

Phormidium subincrustatum Fritsch et Rich
Greenish brown mucilaginous mass forming a layer on submerged sand in a big gutter (8.5), Aurangabad (1-11-75).

Phormidium tenue (Menegh.) Gomont
Dark green mucilaginous mass floating in a glass beaker (8.5), Institute of Science laboratory, Aurangabad (8-11-75).

Phormidium uncinatum (Ag.) Gomont
Blue green mass adhering to submerged rocks in Kham river (9), Aurangabad (20-10-75).

Cross walls of the alga are never granulated.

Lyngbya dixitii Kamat
Greenish brown mass adhering to submerged stones in a big gutter (8.7), Aurangabad (6-11-75).

Lyngbya epiphytica Hieron.
Benthic in the swimming pool (8.5), Aurangabad (25-5-76).

Filaments in the Aurangabad form are not epiphytic as in the type and the sheath is slightly broader than in the type. However it agrees in all other respects with the type.

Lyngbya gandhii Kamat
On moist soil and on the submerged soil in a stream (8.5), Pallod (16-1-77).

Cells of this alga are narrower and shorter than those of the type.

Lyngbya gardneri (Setchell et Gardner) Geitler
Blue green masses forming a layer on cement wall of a settling tank (9), Aurangabad (25-9-75).

Lyngyba maharashtrensis Kamat
Blue green mucilaginous masses floating in a tap water culture (8.5), Institute of Science laboratory, Aurangabad (12-3-76).

Lyngbya pusilla (Rabh.) Hansg.
Epiphytic on the filamentous algae attached to small bricks and small stones submerged in a big gutter (8.5), Aurangabad (1-11-75).

Lyngbya stagina Kuetzing f. **non-granulata** Kamat
Bluish green mass adhering to the submerged stones in Kham river (8.5), Aurangabad (3-10-75).

Microcoleus cataractarum Hansg.
Bluish green algae floating and submerged in Beneck's medium culture in laboratory, Institute of Science, Aurangabad (12-3-76).

Microcoleus chthonoplastes Thuret ex Gomont
Bluish green planktonic mass in a big fish nursury tank (8.7), Kelana project (16-1-76).

Microcoleus hospitus Hansg.
Brownish green mucilaginous mass forming a thick layer on sand near water tank on the terrace, Govt. College of Arts & Science, Aurangabad (19-5-76).

Microcoleus tenerrimus Gomont
Blackish green mass forming a layer on the stone wall of Aurangabad caves (12-10-75).

Microcoleus vaginatus (Vaucher) Gomont
Greenish brown mass forming a thick layer on sand near a water tank on the terrace, Govt. College of Arts and Science, Aurangabad (19-5-76).

Nostoc commune Vauch. ex Born. et Flah.
Bluish green, mucilaginous mass along with other algae in a tap water culture (8.5), Institute of Science laboratory, Aurangabad (8-11-75).

Nostoc piscinale Kuetz. ex Born. et Flah.
Along with other algae in a tap water culture (8.5), Institute of Science laboratory, Aurangabad (28-10-75).

Akinetes rarely broader than those of the type.

Nostoc spongiaeforme Agardh ex Born. et Flah. v. **tenue** Rao, C. B.
Bluish green mass forming a layer on moist soils and bricks of oxidation pond, Kanchanwadi (10-10-75).

Cylindrospermum sphaerica Prasad f. **cylindricum** Kamat
Bluish green mass adhering to the submerged roots of *Phoenix* sp. on the bank of a stream (8.5), Farola (2-1-77).

Cylindrospermum vouki Pevalek
Blue green mass forming a layer on sand on the bank of the river (9) near Shekta (21-2-76).

Akinetes are slightly broader and shorter than those of the type.

Anabaena volzii Lemm.
Planktonic and submerged in oxidation pond (9.5), Kanchanwadi (10-10-75).
Scytonema myochrous (Dillw.) Ag. ex Born. et Flah.
Brownish black masses forming a thick layer on the rocks in hill crevices near caves, Aurangabad (2-10-75).
Petalonema densum (A. Br.) Migula
Brownish green mass forming a thick layer on the stone walls of the caves, Aurangabad (2-10-75).
Dichothrix gypsophila (Kuetz.) Born. et Flah.
Brownish green mass forming a thick layer on the cement wall of a cistern (8.5), Subhedari Guest House, Aurangabad (11-9-76).

BOTANY DEPARTMENT,
INSTITUTE OF SCIENCE,
AURANGABAD 431 001,
August 15, 1977.

P. V. ASHTEKAR
N. D. KAMAT

CORRIGENDA

Volume 75(2): August 1978
Miscellaneous Note 28

Danaid butterflies attracted to *Heliotropium indicum* (Boraginaceae), an alkaloid containing plant
On page 512, right side column, last word
For hormone
read pheromone

Volume 75(3): December 1978

The changing Wildlife of Kathiawar.
On page 634, right side column, line 10
For District Magistrate
read Political Agent
On page 636, right side column, 2nd para, line 5
For Mullet
read Mulley (or freshwater shark *Wallago attu*)
On page 644, right side column, line 30
For 1975
read June, 1976
On page 644, right side column, line 31
For 1976
read 5th May, 1977.

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater, 4th edition (reprint). 28 plates in colour by Paul Barruel and many other monochrome illustrations. (*in Press*)

The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett. Rs. 10

Birds

The Book of Indian Birds, by Sálim Ali. 11th (revised) edition. 74 coloured and many monochrome plates. (*in Press*)

Checklist of the Birds of Maharashtra, by Humayun Abdulali. Rs. 2.50
(*Price to members Rs.* 2)

Checklist of the Birds of Delhi, Agra and Bharatpur, by Humayun Abdulali & J. D. Panday. Rs. 3.00

Snakes

Identification of Poisonous Snakes, Wall chart in Gujarati, and Marathi. Rs. 5

Plants

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 3rd edition (Reprint). Rs. 40.00
(*Price to members* Rs. 35)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. 2nd edition. (*in Press*)

Miscellaneous

Glimpses of Nature Series Booklets:

1. Our Birds I (with 8 coloured plates) in Kannada Rs. 0.62
2. Our Beautiful Trees (with 8 coloured plates) in Hindi Rs. 0.62
3. Our Monsoon Plants (with 8 coloured plates) in Gujarati, Hindi and Marathi. Rs. 0.80
4. Our Animals (with 8 coloured plates) in English, Gujarati, Hindi, and Marathi. Rs. 1.25

Glimpses of Nature in India (with 40 coloured plates) in English Rs. 7.50
(*Price to members Rs.* 5)

Back numbers of the Society's Journal. Rates on application.

The Society will gratefully accept back numbers of the *Journal*, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Entrance Fees:

Ordinary and Life Members	Rs. 25
Student Members	Rs. 10

Subscription:

(*a*) Ordinary individual Members	Rs. 50
(*b*) Ordinary Corporate Members	Rs. 100
(*c*) Ordinary Members resident outside India	Rs. 85
Life Members	Rs. 750
	(Rs. 250 after 20 years)
Compound Corporate Members	Rs. 1500
Student Members (without Journal)	Rs. 10
Annual subscription to Journal	Rs. 105

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £ 3.50 should be paid annually to the Society's London Bankers—The Grindlays Bank Ltd., 23 Fenchurch Street, London EC3P 3ED. Account No. 1101091.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

CONTENTS

Printed by Bro. Leo at St. Francis Industrial Training Institute, Borivli, Bombay 400 092 and published by Editors: J. C. Daniel, P. V. Bole and A. N. D. Nanavati for Bombay Natural History Society, Hornbill House, Shahid Bhagat Singh Road, Bombay 400 023.

JOURNAL
of the
Bombay Natural History Society

Vol. 76, No. 2

Editors : J. C. Daniel, P. V. Bole & A. N. D. Nanavati

AUGUST 1979 Rs. 35

NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8.20×5.60 cm (No. 2 Brownie) and on glossy glazed paper.

6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name, with the abridged titles of journals or periodicals underlined (italics) and titles of books *not* underlined (roman type), thus:

Banerji, M. L. (1958): Botanical Exploration in East Nepal. *J. Bombay nat. Hist. Soc.* 55(2):243-268.

Prater, S. H. (1948): The Book of Indian Animals. Bombay. Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Banerji 1958).

9. *Synopsis*: Each scientific paper should be accompanied by a concise, clearly written synopsis, normally not exceeding 200 words.

10. *Reprints*: Authors are supplied 25 reprints of their articles free of charge. In the case of joint authorship, 50 copies will be given gratis to be distributed among the two or more authors. Orders for additional reprints should be in multiples of 25 and should be received within two weeks after the author is informed of the acceptance of the manuscript. They will be charged for at cost plus postage and packing.

11. The editors reserve the right, other things being equal, to publish a member's contribution earlier than a non-member's.

Hornbill House,
Shahid Bhagat Singh Road,
Bombay 400 023.

EDITORS,
Journal of the Bombay Natural History Society.

VOLUME 76 No. 2—AUGUST 1979

Date of Publication: 28-4-1980

CONTENTS

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1979 AUGUST Vol. 76 No. 2

OBSERVATIONS ON THE OVIPOSITION BEHAVIOUR IN *APOCRYPTA BAKERI* JOSEPH (TORYMIDAE: HYMENOPTERA)[1]

U. C. Abdurahiman and K. J. Joseph[2]

(*With two text-figures*)

Apocrypta bakeri Joseph is a cleptoparasite of the agaonid, *Ceratosolen marchali* Mayr, breeding in the receptacles of *Ficus hispida* L. Observations on the process of oviposition and the related behaviour of these torymid wasps are briefly given and discussed. The presence of the abdominal keel, formed of the telescopically arranged basal segments is a unique feature and facilitates the penetration of the ovipositor across the fig wall. The eggs are deposited only in those ovaries of *Ficus* where the agaonid, *C. marchali* has deposited its egg and injected the secretion from its poison glands. The presence of these 'internal host factors' possibly detected by the sensillae present at the tip of the ovipositor of *A. bakeri* inform this insect about the suitability or otherwise of the fig ovary for oviposition and serve as factors determining successful oviposition.

Introduction

The oviposition behaviour in different genera of fig-inhabiting torymids has been very little investigated. Joseph (1953) observed the process of egg-laying in *Sycoscapteridea* (=*Neosycoecus*) *indica* Joseph. He gave a detailed account of the process of oviposition and the factors determining the same in *Philotrypesis caricae* L., cleptoparasite of *Blastophaga psenes* L. developing in the syconia of *Ficus carica* L. (Joseph 1958 & 1959). Ansari (1966) studied the process of oviposition in *Parakoebelea stratheni* (=*glomeratus*) Joseph. The present paper embodies the results of our study of the oviposition behaviour in *Apocrypta bakeri* Joseph, which develops as a cleptoparasite of the agaonid, *Ceratosolen marchali* Mayr, breeding in the receptacles of *Ficus hispida* L. It is for the first time that the oviposition behaviour of a species of the genus *Apocrypta* is studied.

[1] Accepted July 1977.

[2] Department of Zoology, University of Calicut, Kerala 673635.

Material and Methods

Mature gall figs of *Ficus hispida* were brought to the laboratory. The females of *Apocrypta bakeri* eclosed were reared in the laboratory, feeding them with diluted honey. Tender figs of appropriate stage, freshly collected from the tree were provided to these females for oviposition.

Ovipositing females were observed under the Stereomicroscope for studying the various stages of oviposition and related behavioural aspects. The path taken by the ovipositor inside the fig was traced by cutting the ovipositor at its basal part at the time of oviposition and then by following its course by dissection of the fig wall.

Field observations on the oviposition behaviour in *A. bakeri* were also made to supplement our study in the laboratory.

Observations and Results

In nature, oviposition is more frequent in the morning hours, normally between 6 A.M. and 10 A.M. As many as eight females were observed in the act of oviposition on the same fig. The large scale eclosion of the females in the early morning is one of the probable reasons why a large number of females were observed ovipositing during the morning hours. Under laboratory conditions, the females readily showed oviposition behaviour during the day when suitable tender figs were provided.

The oviposition behaviour in *A. bakeri* can be conveniently divided for our study purpose into 3 different stages.

a) *Selection of a suitable area for insertion of the ovipositor*:

The females on eclosion remain for a while on the fig surface. No distinct pre-oviposition period was observed, and many females accomplished oviposition soon after their eclosion. On the surface of the tender figs, the insect wanders in search of a suitable spot to insert the ovipositor. This search is aided by the antennae, the tips of which are kept in contact with the fig surface as the insect moves along (Fig. 1a). It would seem therefore, that certain olfactory cues perceived by the antennae initially inform the insect about the suitability or otherwise, of the spot to be selected for insertion of the ovipositor. The insect now raises the abdomen to the maximum height possible by straightening the hind legs. Along with this the abdomen is elevated from its normal position. Simultaneously, the seven basal abdominal segments that constitute the ventral abdominal keel are stretched and this part of the abdomen now further brought perpendicular to the thorax (Fig. 1b). The remaining segments of the abdomen along with the terminal ovipositor are now folded down and the tip of the ovipositor is brought in contact with the selected spot, aided by the hind legs (Fig. 1c). Now the insect undertakes a detailed examination of the spot where its ovipositor has touched the fig surface. This seems to be done by means of the sensory setae present at the tip of the ovipositor and its sheaths. On several occasions the insect was found to abandon the initially chosen site and recommence its search for another suitable site.

b) *Penetration of the ovipositor and deposition of the eggs*:

When the suitable spot is finally selected the hind legs are slowly bent downwards and the hypopygium is lowered in stages as the ovipositor pierces and penetrates into the wall of the fig (Figs. 1d & 1e). The penetration of the ovipositor down the fig wall is also aided by the force exerted by waves of contraction of the abdomen starting at its base and travelling rhythmically towards its tip. With the further

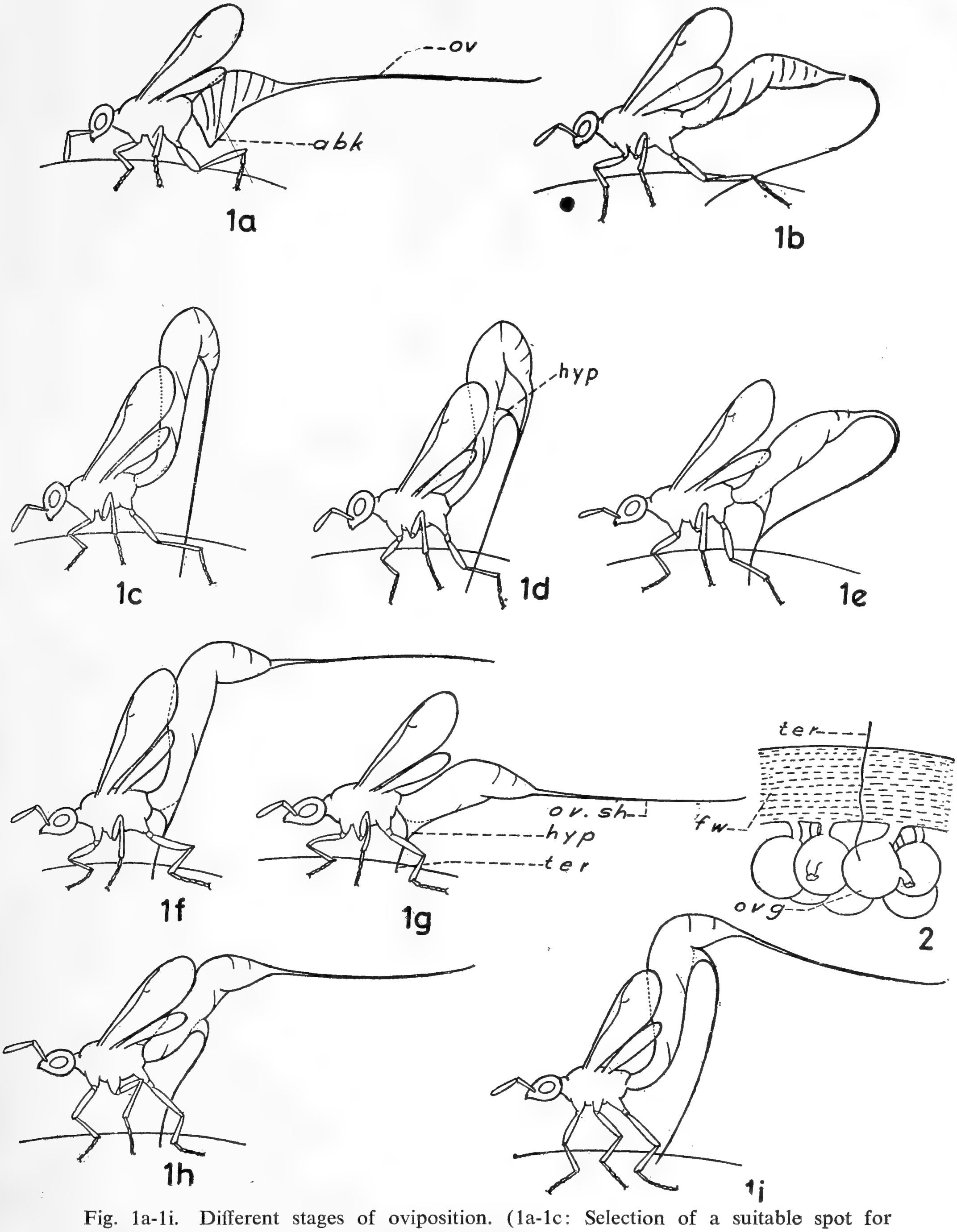


Fig. 1a-1i. Different stages of oviposition. (1a-1c: Selection of a suitable spot for oviposition on the syconium; 1d-1e: Penetration of the ovipositor across the fig wall; 1f-1g: egg laying; 1h-1i; withdrawal of the ovipositor). Fig. 2. Section of a part of the fig showing the path taken by the ovipositor into a *Ficus* ovary.
Abbreviations: abk—abdominal keel; fw—Fig wall; hyp—hypopygium; ov—ovipositor; ov. sh—ovipositor sheaths; ov. g—ovarian gall; ter—terebra (penetrating stylets of the ovipositor).

penetration of the ovipositor its valves which till now helped to fix and direct the ovipositor proper are detached and now they regain their normal resting position horizontal to the body (Fig. 1f). The hypophygium is now considerably lowered and in this position the ovipositor penetrates fully into the fig ovary (Fig. 1g). The egg is deposited in this stage. At times the ovipositor is seen to be slightly pulled out and inserted again, this act being repeated until it has penetrated into the selected gall flower.

The course taken by the ovipositor could be easily traced by cutting the ovipositor in the ovipositing stage and tracing it *in situ* into the gall flower by appropriate dissection (Fig. 2). The egg comes to be deposited in the nucellus of the *Ficus* ovary, normally away from the region of the style, with the small stalk of the egg attached to the ovarian wall.

c) *Withdrawal of the ovipositor*:

After the process of oviposition, the legs are slowly stretched, the hypophygium is raised little by little, and the abdomen is elevated and brought to a perpendicular position with respect to the thorax (Figs. 1h & 1i) resulting in the complete withdrawal of the ovipositor, which is then cleaned with the help of the tibial spurs of the hind legs. The ovipositor is now ensheathed inside its valves and brought to its normal position of rest. The whole process of oviposition is completed within eight to ten minutes.

Factors determining Oviposition:

The internal factors determining egg deposition in *A. bakeri* include the presence of the egg of the host agaonid, *Ceratosolen marchali*, thereby assuring the presence of the secretion of the poison glands of this host insect in the same ovary. When tender figs free of *Ceratosolen* eggs were provided to the females of *A. bakeri*, no eggs were laid eventhough the earlier stages of oviposition behaviour were observed. In some cases, when such figs were examined, the fig ovary did not contain the eggs of *A. bakeri*. This observation supports the possibility of *Apocrypta* laying its eggs only in those gall flowers in which *Ceratosolen* female has already laid its egg and injected the secretion of its poison glands. The presence of this secretion may be detected by means of the sensillae present at the tips of the ovipositor valves and of the stylets of the ovipositor proper.

Discussion

In all the torymid species where oviposition behaviour has been studied, the eggs are laid in the fig ovaries by introducing the ovipositor through the wall of the fig. However, closer analysis of the steps involved in oviposition reveals some important differences. In *Philotrypesis caricae*, the ovipositor is bent with a sharp angle between the elongated segments (8th and 9th) of the abdomen so that the ovipositor can be kept vertical to the fig surface (Joseph 1958). Abdurahiman (1972) observed a similar pattern of oviposition in *Philotrypesis pilosa*, which breeds in the receptacles of *Ficus hispida*. In *Parakoebelea stratheni* (Ansari 1966) and *Sycoscapteridea indica* (Joseph 1953) their abdominal structure does not probably allow such a sharp bending. In *Apocrypta bakeri*, the adaptations for oviposition are entirely different. The well developed abdominal keel (formed by the telescopic arrangement of the seven basal abdominal segments), can be stretched considerably to bring the abdominal tip and the ovipositor sufficiently high so that when the rest of the abdomen carrying the ovipositor is bent downwards, it will permit the ovipositor to penetrate the fig wall by the force of rhythmic contractions exerted upwards and downwards

along the "∩" shaped abdomen. This organisation is a unique feature of the genus *Apocrypta.*

In *Sycoscapteridea indica,* Joseph (1953) did not mention about the exact nature of ovaries of *Ficus infectoria* where the insect deposits its eggs. Ansari (1966) claimed that in *Parakoebelea stratheni,* the eggs are always laid in those ovaries of *Ficus glomerata* which did not contain any other eggs. In *Philotrypesis caricae,* Joseph (1958) showed conclusively that the egg-laying in a particular ovary of *Ficus carica* was dependent on the presence of the egg and more importantly of the secretion of the poison gland of *Blastophaga psenes* in the same ovary. It has been also suggested by the same author that the presence of the latter internal host factor is responsible for stimulating the sensory structures present at the extremity of the valves and stylets of the ovipositor, thus "informing" the torymid on the suitability for oviposition or otherwise of the particular fig ovary. The present studies also showed the role of these same factors (in this case brought about by *Ceratosolen marchali*) in determining the successful oviposition by *Apocrypta bakeri.*

References

Abdurahiman, U. C. (1972): Biology, Morphology and Taxonomy of some fig insects (Chalcidoidea: Hymenoptera) from Kerala. Ph.D. Thesis, Kerala University (unpublished).

Ansari, M. H. (1966): On a new species of fig insect (Chalcidoidea: Hymenoptera) from India. *Indian J. Ent. 28*: 74-83.

Joseph, K. J. (1953): Contributions to our knowledge of fig insects (Chalcidoidea: Hymenoptera) from India. III. Descriptions of three new genera and five new species of Sycophagini, with notes on biology, distribution and evolution. *Agra Univ. J. Res. 2*: 67-69.

——— (1958): Recherches sur les Chalcidiens *Blastophaga psenes* (L.) et *Philotrypesis caricae* (L.) du figuier *Ficus carica* (L.). *Ann. Sci. nat. Zool.* II Ser. 197-260.

——— (1959): The Biology of *Philotrypesis caricae* (L.). parasite of *Blastophaga psenes* (L.) (Chalcidoidea: parasitic Hymenoptera). *Proc. XV Int. Cong. Zool., London,* 1958, Sect. VIII, paper 21, pp. 662-664.

A CONTRIBUTION TO THE FLORA OF MANIPUR[1]

U. SHUKLA[2] AND A. K. BAISHYA[3]

The paper describes 49 genera and 53 species of flowering plants reported as new records for the State of Manipur. It also gives a list of 13 Cryptogams recently collected from Manipur. The collection of *Platycerium wallichii* from forests of Manipur appears to be the first report of its occurrence within India.

The only noteworthy work on the Botany of Manipur State is by Deb (1961), who collected intensively in this region and published a list of 2007 taxa of flowering plants.

The present work is based on authors own collections in Manipur during April-May, 1975. The grasses have been described elsewhere.

Platycerium wallichii commonly called the 'Stag-horn fern' which is earlier reported from Malay Peninsula and Tenasserium has been collected from Moreh, on the border of Burma, well within Indian territory. It is fairly common as epiphyte and is being reported here for the first time from India. *Andrographis, Evolvulus, Grangea, Holarrhena, Mosla, Pongamia, Sonchus, Sparaganium, Sphaeranthus, Stachytarpheta* and *Wrightia* are new genera for the State.

In the following enumeration, species are arranged alphabetically under their respective families which are also listed alphabetically. For each species precise locality, date of collection and field number have been given. Field numbers without collectors name are all collections of *Shukla*. Altitude of the locality, name of plants in Manipuri language and local uses, when available are provided.

[1] Accepted November 1977.

[2] Botanical Survey of India, Central Circle, Allahabad.

[3] Botanical Survey of India, Eastern Circle, Shillong-793 003.

PHANEROGAMS

ACANTHACEAE

Andrographis ovata Benth.
Herb, flowers whitish.
Only one plant seen.
Moreh, 8.5.1975, 63678.

AMARANTHACEAE

Alternanthera philoxeroides (Mart.) Griseb.
Creeping and trailing herb, stem hollow, inflorescence silvery white.
Very common in water, wasteland and in marshes in and around Keibul. Apparently this species is not used locally. In Meghalaya, however, it is used as a leaf vegetable.
Keibul Lamjao, on floating island (750 m), 26.4.1975, *Jain* 63320; Keibul (750 m), 28.4.1975, *Jain* 63389; Near Logtak (750 m), 29.4.1975, *Jain* 63453.
This species is a native of Brazil and seems a very recent introduction and now naturalised in various places.

Alternanthera repens (Linn.) O. Ktze.
Trailing herb, inflorescence white.
Growing on marsh and gravelly soil.
Logtak, Tongbram village (750 m), 29.4.1975, *Jain* 63451.
The species is a native of America but now naturalised in many parts of India. Its first report in India was from near a railway line on Monkey hill plateau in Khandala

ghats. Subsequently collected in eastern India in 1941 and 1957.

AMARYLLIDACEAE

Crinum amoemum Roxb.
Herb about 50 cm tall, flowers white in terminal whorl. In large numbers in a shady place on a hillock. Tipaimukh road, Mission compound (1350 m), 6.5.1975, 63650.

APOCYNACEAE

Holarrhena antidysenterica (Linn.) Wall. ex DC.
Small tree upto 2 m high. Flowers white, scented.
Moreh, 8.5.1975, 63674.

Wrightia tomentosa (Roxb.) R. et S.
About 7 m tall tree. Flowers pale yellow, scented.
In roadside ravine.
Moreh, Indo-Burma road, 9.5.1975, 63727.

ASTERACEAE

Erigeron bonariensis Linn.
Herb upto 45 cm tall.
Not common.
Tongbram village, Near Logtak Lake (750 m), 29.4.1975, *Jain* 63469.

Grangea maderaspatana (Linn.) Poir. *Local name*: 'Laibongon'.
Herb, inflorescence yellow.
Very common on roadside. Decoction used for giving bath in case of Eczema and other skin diseases.
Keibul, on way to floating island (750 m). 26.4.1975, *Jain* 63314.

Lactuca gracilis DC.
Churachandpur, Tipaimukh road (1250 m). 2.5.1975, 63546; Ngaram village, near Thanga (750 m), 29.4.1975, *Jain* 63458.

Sonchus asper (Linn.) Hill *Local name*: 'Khomthopi'.
Herb upto 60 cm tall, ray-florets white.
Keibul, in moist places (750 m), 28.4.1975, *Jain* 63441.

Sonchus wightianus DC. subsp. **wightianus** DC.
Small rosette herb with glabrous stem, inflorescence yellow.
Churachandpur, Tipaimukh road (1250 m), 2.5.1975, 63554.

Sphaeranthus indicus Linn.
Spreading herb. Very common in wastelands.
Keibul (750 m), 28.4.1975, *Jain* 63397.

BORAGINACEAE

Heliotropium ovalifolium Forsk.
Low prostrate herb, flowers white, seeds black. Common in open fields in damp patches.
Churachandpur, Tipaimukh road (1250 m), 2.5.1975, 63548.

COMMELINACEAE

Commelina appendiculata C.B. Cl.
Small herb, flowers blue, bracts villous. Not common.
Churachandpur, behind Beat Office (1260 m), 2.5.1975, 63563.

CONVOLVULACEAE

Evolvulus nummularis Linn.
Creeping herb, flowers white. Very common on roadside.
Moreh, Indo-Burma road, 9.5.1975, 63722.

CYPERACEAE

Cyperus brevifolius (Rottb.) Hassk.
Small sedge. Common near stream.
Seprameina, 12.5.1975, 63785.

Verma (1971) reported it from all regions in eastern India except Manipur.

Fimbristylis aestivalis (Retz.) Vahl *Local name*: 'Kankhanchabei'.

A very variable species, 15 - 40 cm tall. Common in marshy places and floating island.

Keibul (750 m), 26.4.1975, *Jain* 63311; Keibul Lamjao, 27.4.1975, *Jain* 63378 & 63379. Verma (1971) does not report it from Manipur.

Euphorbiaceae

Croton bonplandianum Baill.

Herb upto 75 cm tall, male flowers white. Common in wasteland and roadside.

Imphal-Dimapur road (795 m), 11.5.1975, 63747.

Euphorbia hirta Linn. *Local name*: 'Pakhamba-maton'.

Trailing herb, inflorescence pedunculate.

Logtak - Tongbram village (750 m), 29.4.1975, *Jain* 63490.

Labiatae

Mosla ocymoides Buch. - Ham. ex Benth.

Small herb, flowers violet. Common in roadside nala.

Churachandpur, near Churachandpur College (1250 m), 1.5.1975, 63536.

Lauraceae

Beilschmiedia brandisii Hook. f.

Tree upto 7 m tall, fruits dark violet. Not common.

Koubru Leikha, 12.5.1975, 63794.

Lythraceae

Ammannia multiflora Roxb.

Small herb, entire plant purplish. Common in moist places and dried-up paddy fields.

Churachandpur, Tipaimukh road 2 Km (1250 m), 2.5.1975, 63556; Seprameina, 12.5.1975, 63792.

Mimosaceae

Acacia farnesiana Willd. *Local name*: 'Chingonglei'.

Inflorescence yellow, fruits 7-10 cm long. Common. Powder of seeds with water used in Cholera.

Near Logtak Lake (750 m), 29.4.1975, *Jain* 63449; Imphal-Dimapur road, 1 Km (795 m), 11.5.1975, 63758.

Albizzia odoratissima Benth. Local name: 'Uin'.

Tree in buds.

Tongbram village, near Logtak Lake (750 m), 29.4.1975, *Jain* 63447.

Moraceae

Maclura cochinchinensis (Lour.) Corner

Scandent spiny shrub, 4-5 m tall in the ravines. Rare.

Churachandpur, near Horticultural Sub-Station (1250 m), 4.5.1975, 63614.

Myrsinaceae

Ardisia solanacea (Poir.) Roxb.

Shrub upto 4 m tall, flowers white to light or dark purple. Common along river bank.

Moreh, 8.5.1975, 63710 & 63711.

Myrtaceae

Syzygium formosum (Wall.) Masamune

Tree about 10 m tall.

Moreh, 8.5.1975, 63709.

Syzygium griffithii (Duthie) Merr. & Parry.

Tree about 5 m tall. Common in rocky soil. Fruits edible.

Moreh, 8.5.1975, 63676.

ONAGRACEAE

Epilobium angustifolium Lamk.
Small herb, flowers yellow. On road side.
Saikot village (1450 m), 5.5.1975, 63622.

ORCHIDACEAE

Cirrhopetalum guttulatum Wall. ex Hook. f.
Epiphytic on *Albizzia* sp., flowers purple. Rare.
Tipaimukh road, 11 km (1350 m), 6.5.1975, 63655.

Coelogyne graminifolia Par. & Reichb. f.
Herb hanging down from rocks, in fruits. Not common.
Moreh, 8.5.1975, 63687.

Coelogyne suaveolens Hook. f.
Epiphytic herb, flowers white.
Common.
Moreh, 8.5.1975, 63698.

Dendrobium williamsonii Day et Reichb. f.
Epiphytic herb, flowers white. Common.
Moreh, 8.5.1975, 63693.

Eria fragrans Reichb. f.
Epiphytic herb, fruits green, elongated. Common inside the forest.
Moreh, 8.5.1975, 63701.

Geodorum densiflorum Schlechter
Terrestrial herb, flowers white. Not Common.
Saikot (1450 m), 5.5.1975, 63646.

Renanthera imschootiana Rolfe
Epiphytic herb, flowers deep red.
Stated to be common in Koubru forest.
Imphal-Dimapur road, 11 km, Orchid nursery (795 m), 11.5.1975, 63776.

Sarcanthus filiformis Lindl.
Epiphytic herb on *Ficus* sp., flowers small, purplish. Not common.
Maullum (1375 m), 3.5.1975, 63590.

PAPILIONACEAE

Pongamia pinnata (Linn.) Pierre
Road side tree upto 10 m high, flowers light purple. Possibly introduced.
Imphal-Dimapur road, 7 km (795 m), 11.5.1975, 63760.

POLYGONACEAE

Polygonum hydropiper Linn.
Herb upto 50 cm tall, flowers white. Growing on marshy places.
Logtak-Tongbram village (750 m), 29.4.1975, *Jain* 63492.

Rumex maritimus Linn. *Local name*: 'Torong-khonchak'.
Herb, fruiting perianth armed as well as unarmed.
Common on road side. Leaves applied on Ring worm infection.
Keibul Lamjao (750 m), 26.4.1975, *Jain* 63327.

POTAMOGETONACEAE

Potamogeton octandrum Poir.
Aquatic floating herb. Common.
Thanga-Logtak (750 m), 29.4.1975, *Jain* 63456.

PRIMULACEAE

Lysimachia javanica Bl.
Annual herb, about 75 mm tall, flowers white. Common in moist places.
Churachandpur-Imphal road, 2 km (1250 m). 4.5.1975, 63601.

RUBIACEAE

Canthium gracilipes Kurz. *Local name*: 'Heibi'.

Small tree in young fruits. Not common.
Keibul (750 m), 28.4.1975, *Jain* 63401.

Wendlandia coriacea DC.
Shrub upto 2.5 m tall, inflorescence dried-up. Growing on hill slopes.
Saikot (1450 m), 5.5.1975, 63631.

SOLANACEAE

Datura suaveolens Willd. *Local name*: 'Savaidak'.
Herb upto 1.5 m tall, flowers white.
Common in wasteland.
Imphal-Dimapur road, 10 Km. (795 m), 11.5.1975, 63762.

Solanum khasianum C.B.Cl. *Local name*: 'Singkhaga'.
Prickly herb, fruits 2.5 cm diameter, yellow. Fruits were seen being fed to captive barking deer.
Keibul Lamjao (750 m), 26.4.1975, *Jain* 63339.

TILIACEAE

Grewia elastica Royle
Shrub; petals dull white, stamens yellow. Common on hill slopes.
Saikot (1450 m), 5.5.1975, 63642.

Grewia sapida Roxb.
Low herb, branching from the base. Common. Ripe fruits edible.
Keibul, behind Forest Office (750 m), 30.4.1975, 63521.

Triumfetta rhomboidea Jacq.
Shrub about 75 cm tall, flowers small, yellow. Common in open fields.
Churachandpur, near Horticultural Sub-Station (1250 m), 4.5.1975, 63603.

TYPHACEAE

Sparaganium simplex Huds.
Tall herb. Not common.
Keibul Lamjao (750 m), 26.4.1975, *Jain* 63324.

VERBENACEAE

Clerodendrum viscosum Vent.
Shrub upto 2 m high, calyx red, fruits black. Common on road side.
Moreh, 8.5.1975, 63670.

Stachytarpheta indica Vahl
Herb upto 1 m tall, flowers white. Common on road side.
Seprameina, 12.5.1975, 63781.

ZINGIBERACEAE

Curcuma zedoaria Rosc.
Herb in inflorescence, bracts red, flowers yellow, anthers tailed. Common.
Churachandpur, behind Beat House (1260 m), 30.4.1975, 63522; Muallum (1375 m), 3.5.1975, 63576.

CRYPTOGAMS

CYCADACEAE

Cycas pectinata Griff.
Woody shrub on hill slope. Rare.
Keibul, behind Forest Beat Office (750 m), 30.4.1975, 63805.

EQUISETACEAE

Equisetum debile Roxb. ex Vancher
Erect rhizomatous herb, 20 cm—1 m tall. Not common. Occassionally met with in moist shady places.
Moreh, 8.5.1975, 63712; Imphal-Dimapur road, 1 Km (795 m), 11.5.1975, 63774.

LYGODIACEAE

Lygodium japonicum (Thunb.) Sw.
Herb, growing on hill slopes. Not common.

MARSILEACEAE

Marsilea minuta Linn.
Aquatic herb in roadside ditch. Not common.
Keibul, near Wild Life Office (750 m), 30.4.1975, 63499.

Marsilea minuta Linn. var. **indica** Gupta
Herb about 5 cm tall in sporocarp .Abundant in dried up road side depression. Growing in patches forming a continuous mat.
Imphal-Dimapur road (795 m), 11.5.1975, 63764.

POLYPODIACEAE

Platycerium wallichii Hook. 'Stag-horn fern'
Epiphytic, fronds dichotomously forked, hanging downwards, sori at the undersurface of the fork. Fairly common.
Moreh, 8.5.1975, 63668.
Panigrahi (1961) stated that this taxon is likely to occur in eastern India. He cited Beddome (1883) where distribution is shown as Malay Peninsula, Tenasserium. The present collection from Moreh, is therefore, a new record for India.

Pyrrosia nuda (Gies.) Ching
Herb, erect or hanging down from rocks and trees, sori marginal. Very common.
Moreh, 8.5.1975, 63681.

PTERIDACEAE

Pteridium aquilinum (Linn.) Kuhn
Herb upto 1 m tall on rocky soil. Not common.
Keibul, behind Beat Office (750 m), 30.4.1975, 63518.

Pteris cretica Linn.
Herb upto 75 cm tall, sori continuous and marginal. Not common.
Churachandpur, behind Beat Office (1276 m), 2.5.1975, 63564.

Pteris quadriaurita Retz.
Herb upto 1.5 m tall, sori marginal. Rare.
Muallum (1375 m), 3.4.1975, 63572.

Sphenomeris chinensis (Linn.) Maxon var. **tenuifolia** (Sw.) N. C. Nair.
Common on road side hill slopes.
Imphal-Dimapur road (795 m), 11.5.1975, 63757.

SALVINIACEAE

Salvinia nutans Hoffm.
Small floating herb, leaves glandular, small. Not common.
Keibul Lamjao (750 m), 2.4.1975, *Jain* 63373.

SELAGINELLACEAE

Selaginella amblyphylla Alston
Herb. Common on road side hill slopes.
Koubru-Leikha, 12.5.1975, 63798.

Inspite of the work of Deb (1961) and present additional records, Manipur must be considered as an underexplored state. Further intensive work may bring to light many hitherto unreported species. Even species new to science may be expected.

ACKNOWLEDGEMENT

We acknowledge our sincere thanks to Dr. S. K. Jain, Deputy Director, Botanical Survey of India, Shillong, for extending the facilities, encouragement and guidance.

References

Beddome, R. H. (1883): Handbook of Ferns of British India and Ceylon. New Delhi.

Deb, D. B. (1961): Monocotyledonous Plants of Manipur Territory. *Bull. Bot. Surv. Ind.* 3(2): 115-138.

——— (1961): Dicotyledonous Plants of Manipur Territory. ibid. 3(3+4): 253-350.

Panigrahi, G. & Patnaik, S. N. (1961): Pteridophytes of Eastern India. *Ind. For. 87*: 242-247.

Verma, D. M. (1971): Cyperaceae of Assam and neighbouring area. Ph.D. Thesis, Gauhati University.

DRY SKIN PREPARATIONS OF FROGS AND TOADS AS AIDS FOR THEIR TAXONOMY[1]

The paper describes the modified method of preparation of anuran dry skins. It also discusses in detail, for the first time, utility of the dry skin preparations as an additional, important, convenient and very useful means of amphibian taxonomy. For the purposes of discussion, black and white photographs of dry skin preparation of one species each of *Bufo, Microhyla* and *Philautus* and four species of *Rana* have been taken into account. Wherever necessary differences in the male and female of a species have also been presented.

S. Y. Paranjape[2] and Leela Mulherkar[3]

(*With eight text-figures*)

Introduction

The method developed by Kincaid (1948) for preserving the colour pattern of the skins of frogs is very useful (Knudsen 1966). It appears to have been used by both of them solely from the point of view of colour preservation.

It is known that, besides the skin colour, the nature of the skin and its marking patterns, the nature of fingers and toes, the extent of webbing, separation of metatarsals by the web and nature of the metatarsal tubercles happen to be some of the characters of taxonomic importance in the anuran classification. These characters, being essentially external ones, are far more valuable than other internal characters, in visual indentification of the species during field work (Paranjape and Mulherkar 1979).

From this point of view, the earlier 'skin technique' has been modified to a certain extent with a view to retaining those—characters as far as possible. Our observations, discussed later, indicate that the modified method is taxonomically quite useful. Besides, such dry skin preparations are very convenient for demonstration, projection, etc. and that the characters can be studied any time in and out of the season, irrespective of the availability of the amphibian under study.

Material and Method

To prepar an album of dry skins the following procedure is followed:

The frog (or toad) is etherised. It is then quickly skinned by taking incision mid-ventrally along the body and carrying it on to the limbs. The skin along the jaws and on the head region is separated from the body, as it is somewhat firmly attached. Elsewhere, the skin being loosely attached to the body presents very little difficulty in its separation. The incisions along the limbs are continued upto $\frac{1}{2}$ or $\frac{3}{4}$ of the palm and the sole regions. Thereafter, the skin on the digits (i.e. fingers and toes) is removed by gently pulling of the separated skin, in the manner similar to

[1] Accepted January 1978.

[2] Department of Biology, Modern College, Pune-411 005.

[3] Department of Zoology, University of Poona, Pune-411 007.

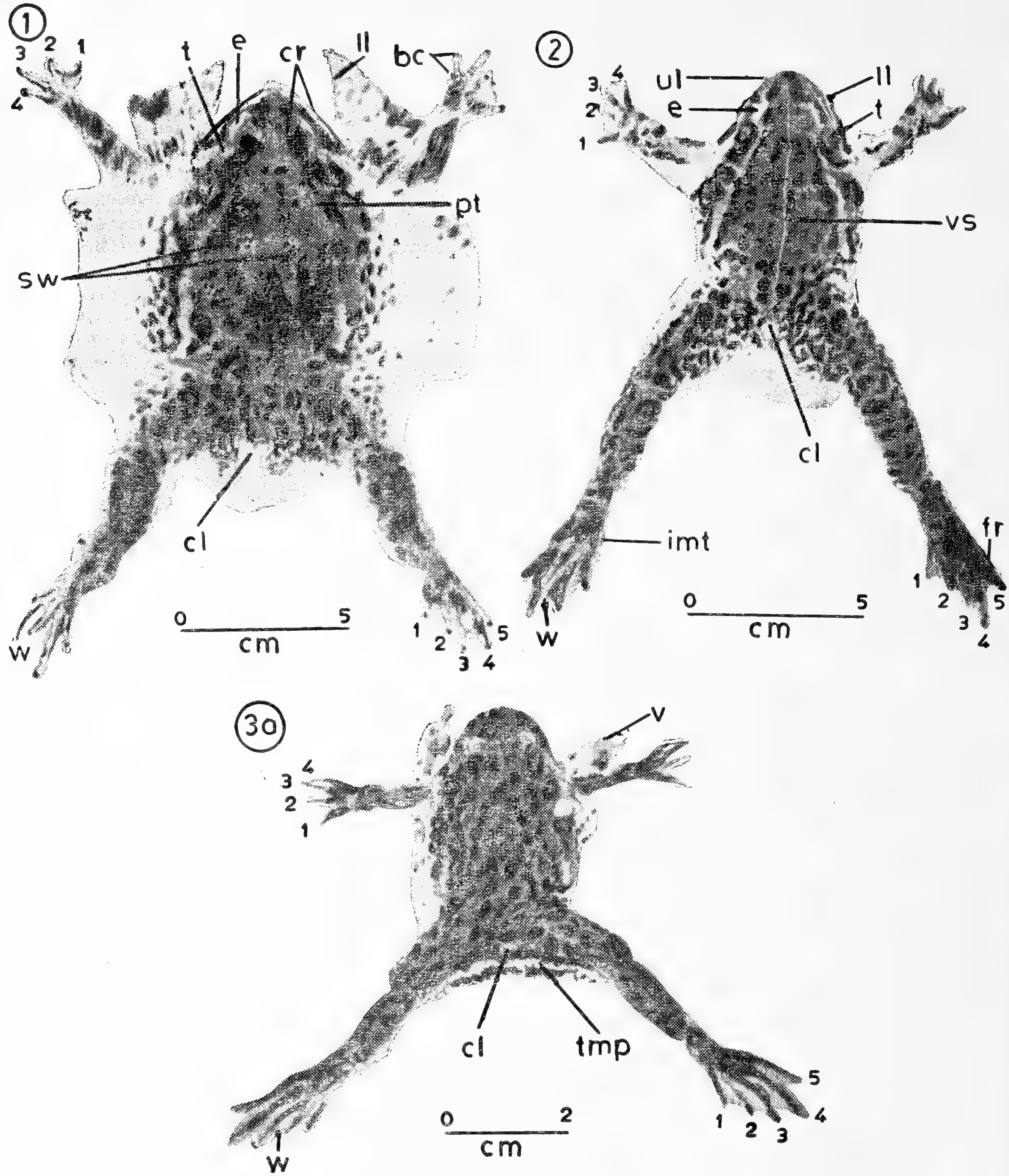


Fig. 1. *Bufo melanostictus* Schneider; Common Indian Toad (Fam. Bufonidae, Genus *Bufo*). Fig. 2. *Rana tigerina* Daud. Indian Bull Frog (Fam. Ranidae, Genus *Rana*, Subgenus *Rana*). Fig. 3a. *Rana cyanophlyctis* Schneider. Skipper Frog (Fam. Ranidae, Genus *Rana*, Subgenus *Rana*). A male.

Abberviations: bc, black cornifications; cl, cloacal aperture; cr, cranial ridges; e, eye; fr, fringe; imt, inner-metatarsal tubercle; 11, lower lip; sw, two series of warts; t, tympanum; tmp, typical marking pattern; ul, upper lip; v, vocal sac; vs, vertebral streak; w, web.

the removal of a sock. The entire skin is then spread by floating it in water. The everted skin on the digits needs either very careful turning outside in or extending of the incision to each digit. With the support of the phalanges thus lost, this region presents difficulty in the spreading. The extension of the web along the digits, which has taxonomic importance (Boulenger 1920; Daniel 1963), is also not effectively spread.

In order to overcome these difficulties and depending upon the size of the animal, metacarpals/metatarsals were either partly or wholly retained together with the phalanges, by adjusting the extent of the incisions in the palm/sole regions. For example in large sized specimens they were partly, proximally cut. In small and delicate specimens these bony structures were entirely retained. It has been observed that retention of the phalanges not only facilitates proper spreading of the web, but also preserves the nature of the digit and its tip. Similarly by retaining the metatarsals the extent of separation of the outer metatarsals can be studied. Alongwith these characters careful retention of the vocal sacs, outer and inner metatarsal tubercles, when present, aids further in enhancing the value of the dry skin preparation from the taxonomic point of view. Thus Kincaid's method is modified by us (Paranjape and Mulherkar 1977).

The rest of the procedure regarding spreading, mounting, preservation of the dry skin preparation etc., was mostly followed as described by Knudsen (1966). However, the shape of the trunk region is particular in certain families of frogs. The trunk is rather short, much broad in the middle and shows a sudden posterior narrowing in frogs belonging to Microhylidae and Rhacophoridae. With the usual mode of spreading (Figs. 1-4 & 6-8) it was noticed that the typical shape is not clearly visible. Therefore the mode of spreading was also modified in the case of a microhylid frog (Fig. 5). In this preparation the limbs were so positioned as to simulate their natural arrangement as far as possible. The result was found to be encouraging and to this extent also the earlier method has been modified by us.

The modified method besides retaining the skin-colour, ensures retention of other external characters of taxonomic importance as can be seen from the discussion.

Discussion

Various external characters that are retained in the modified method enable in classifying anuran amphibia. Some specific-examples are as follows:

1. Nature of the skin: In this character, whether the skin is warty, tuberculate, granular or smooth is taken into account. For example, the skin is distinctly warty or heavily tuberculate in toads (Fig. 1). It is generally smooth (Fig. 2) or granular in frogs. (Most of the frogs belonging to the genus *Rana* dorsally bear longitudinal skin-folds or ridges. They are of varying lengths and give a characteristic wrinkled appearance. Due to flattening and pressing this character cannot be retained in the dry skin preparations). Further observation of the skin of toad indicates presence of a pair of large parotoid glands (Fig. 1) that are always present in most of the toads (absent in the genus *Ansonia*) and absent in frogs. Further, the presence of two series of heavy, roundish, black-tipped warts, prominent cranial ridges, tips of fingers and toes and tubercles on palm crowned with dark black cornifications indicate that the toad-skin is of an adult of *Bufo melanostictus* (Fig. 1). It can be noted here that these characteristic black

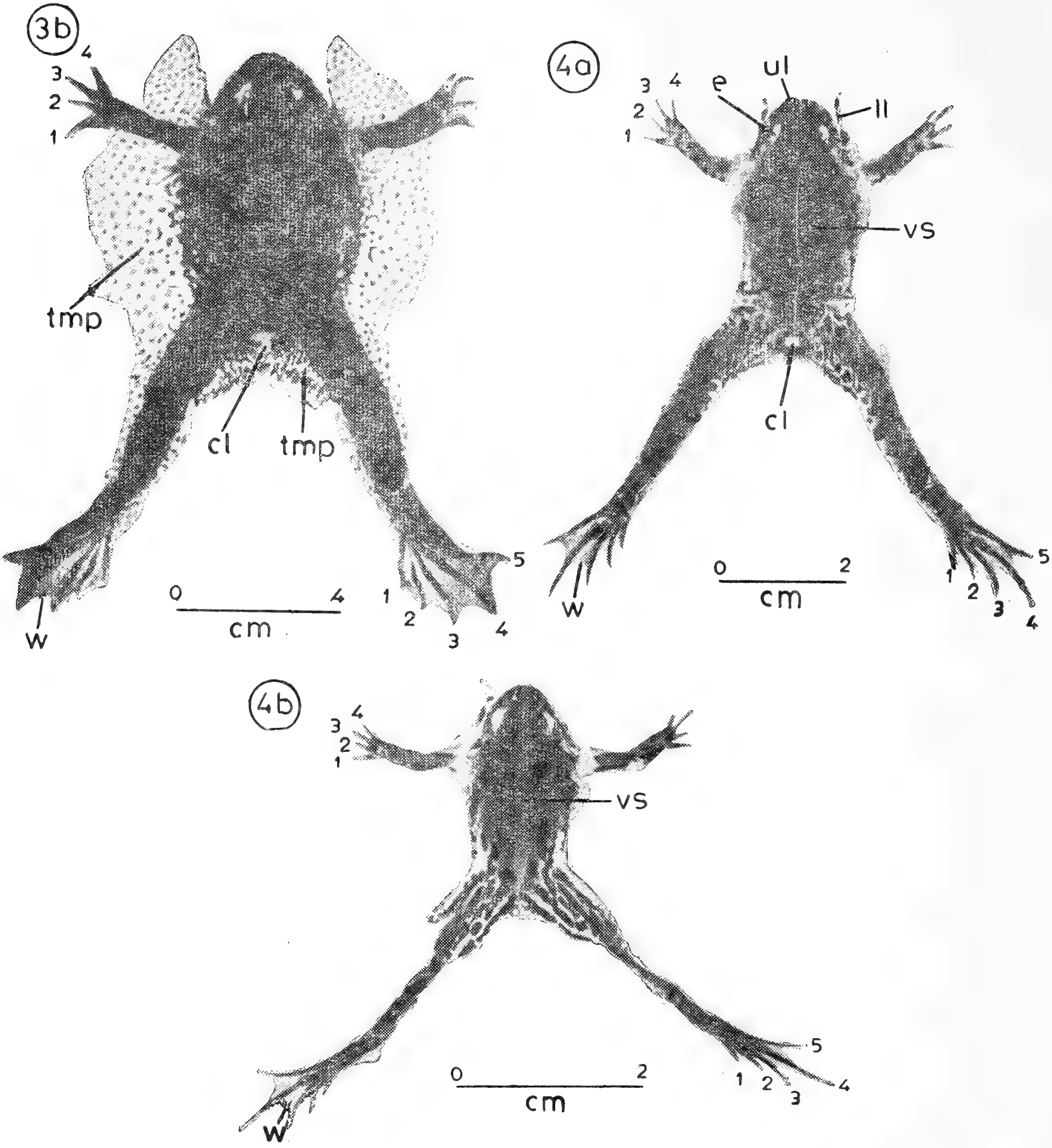


Fig. 3b. *Rana cyanophlyctis* Schneider. Skipper Frog. A female. Fig. 4a & 4b. *Rana limnocharis* Weign. Indian Cricket Frog or Grass Frog (Fam. Ranidae, Genus *Rana*, Subgenus *Rana*).

Abbreviations: cl, cloacal aperture; e, eye; tmp, typical marking pattern; ul, upper lip; vs, vertebral streak; w, web.

cornifications are peeled off and thus lost in preserved specimens (Daniel 1963). They are, however, nicely retained in the preparation mentioned above.

2. *Colour and marking patterns*: These are also of taxonomic importance which are seen in actual dry skin preparations. However, in black and white photographic reproduction provided here, only the marking pattern can be described here. Frog's skin is invariably variously marked with spots, bars, patches on the dorsal side. They show considerable size and pattern variation in the different species. Ventrally the skin is creamy or yellowish white and at times mottled or stippled. From the nature of spots one can readily distinguish three species of the genus *Rana,* namely, *R. tigerina* (Fig. 2) from *R. cyanophlyctis* (Fig. 3) or from *R. limnocharis* (Fig. 4). Further it can be seen that spots in the form of transverse bands are practically spread across the hind-limbs in *R. tigerina* while they are not band-like and do not reach across the hind-limbs in *R. cyanophlyctis* and *R. limnocharis.* By colour and marking pattern the male and female of a species can also be identified. For example, the male of *R. cyanophlyctis* (besides its small size and bluish vocal sacs) bears a white band with dark edges on the back of the thighs (Fig. 3a). Although white spots are present in the female of this species a continuous band is wanting in it. Similarly skin of the female of *R. cyanophlyctis* ventrally shows a dotted appearance (Fig. 3b), especially so, during the breeding season. The male lacks such an appearance (Fig. 3a). Sometimes the marking pattern is so typical of a species that a mere look enables one to visually identify it reasonably correctly, in the field. For example, there is a characteristic blackish-brown mark that begins between the eyes and touching them. It extends posteriorly, shows deep emarginations as it broadens and finally it spreads over the thighs in the form of two stripes. It is flanked by relatively uniform greyish coloration. This is characteristic of *Microhyla ornata* (Fig. 5). A rhacophorid frog, *Philautus bombayensis,* shows considerable colour variation but generally shows a dice-box shaped mark on the dorsal side of the trunk. It has a faint coloured band-like mark slightly constricted in middle, broad at the ends and it is flanked by dark coloration (Figs. 6, 7). In routine preservation not only the colour but this marking pattern also generally fades away.

Presence of certain marks also helps in identification. For example, there is seen in some forms a V shaped mark extending between the eyes. It is narrow, acutely pointed and more V-like in *R. limnocharis* (Fig. 4a) while broad, obtusely pointed in *P. bombayensis* (Fig. 7). Similarly marking pattern of lips is also useful. For example, in *R. tigerina* (Fig. 2) the upper lips shows a light canthal streak with blackish elongated spots and the lower shows large black spots. In *R. limnocharis* the lips bear dark bars (Fig. 4a).

The mid-dorsal vertebral streak is yet another marking pattern that aids in identification. It may be absent altogether, as is the case in *R. cyanophlyctis* (Fig. 3) or may be present. If present it may be complete, that is extending from the snout to vent or may be incomplete, that is reaching the vent but not the snout. Similarly, it may be narrow or broad. The streak can also be of different coloration. For example, in *R. tigerina* (Fig. 2) the vertebral streak is narrow, complete and pale yellowish-white in colour. in *R. limnocharis* (Fig. 4a) it is narrow, generally incomplete and pale yellowish-white in couour. In another type of *R. limnocharis* (Fig. 4b) it is however, complete, broad and pinkish

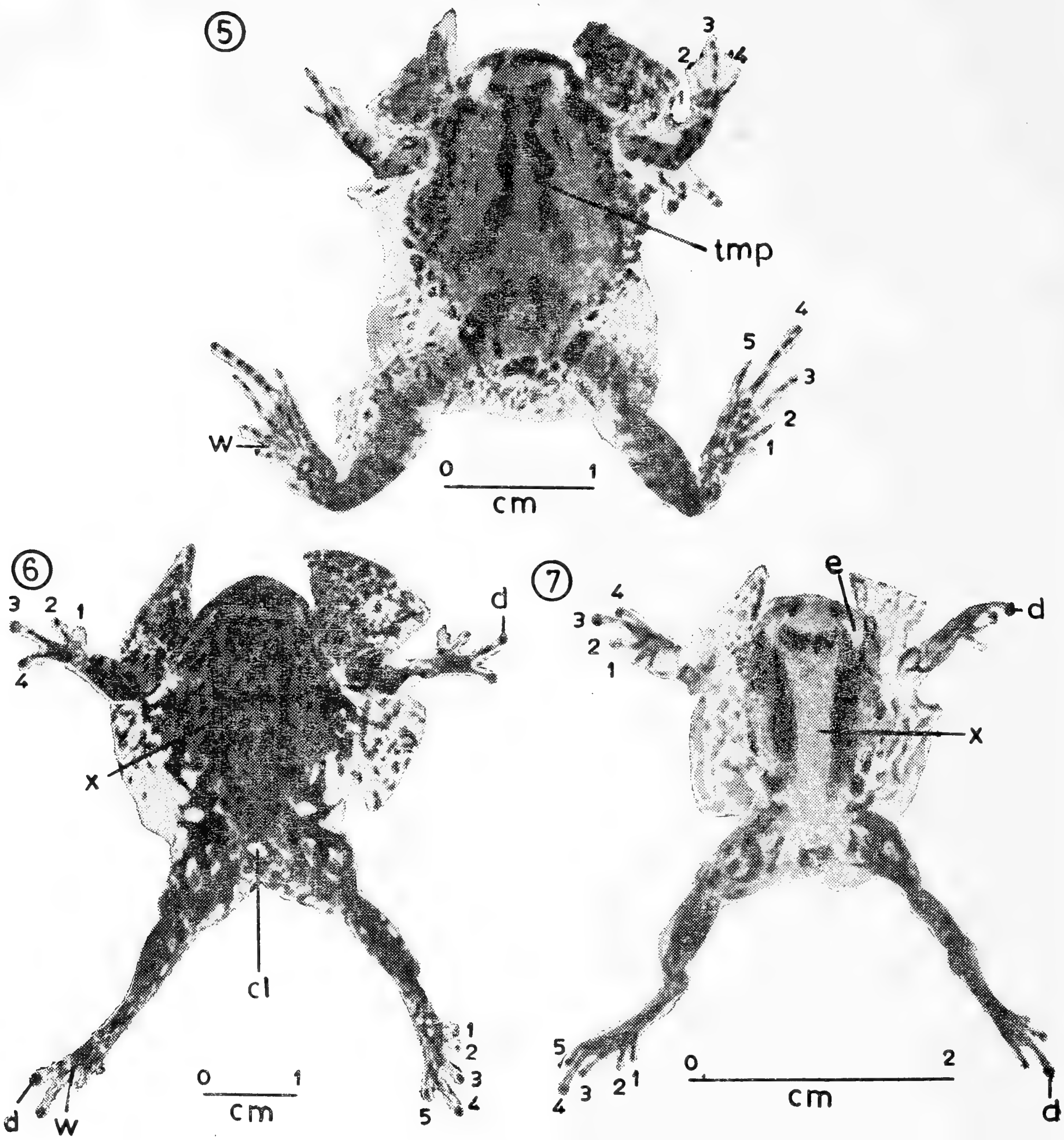


Fig. 5. *Microhyla ornata* Dum. & Bibr. Narrow-mouthed frog. (Fam. Microhylidae, Genus *Microhyla*). Figs. 7 & 8. *Philautus bombayensis* Gunth. (Fam. Rhacophoridae). *Abbreviations*: cl, cloacal aperture; d, disc; e, eye; tmp, typical marking pattern; w, web; x, area of the disc-boxlike mark.

brown in colour.

3. Fingers: These are also helpful in identification. The tips of the fingers may be with or without discs. They may be long and slender or short and thickly set. The relative lengths of the 1st and 2nd fingers is also a diagnostic character.

For example the fingers (as also the toes) bear somewhat oval adhesive discs in *R. temporalis* (Subgenus: *Hylorana,* genus: *Rana*) (Fig. 8). This is an adaptation for its rocky-stream dwelling or semi-arboreal habitat. The fingers (as also the toes) in tree-frogs (Fam. Rhacophoridae) possess circular adhesive discs, as can be seen in *P. bombayensis* (Figs. 6 & 7).

The first finger is nearly as long as or a little longer than the second in *R. temporalis, R. limnocharis.* It is generally longer in *R. tigerina,* distinctly so in the Indian burrowing frog, *R. breviceps* (Subgenus: Tomopterna). It is more or less of equal length in *R. cyanophlyctis* and quite short in *M. ornata.*

4. Toes and webbing pattern: Reference has already been made (in 3) whether the tips of the toes are with the discs or not. Other toe-features of relatively minor importance are whether they are long and slender or some-

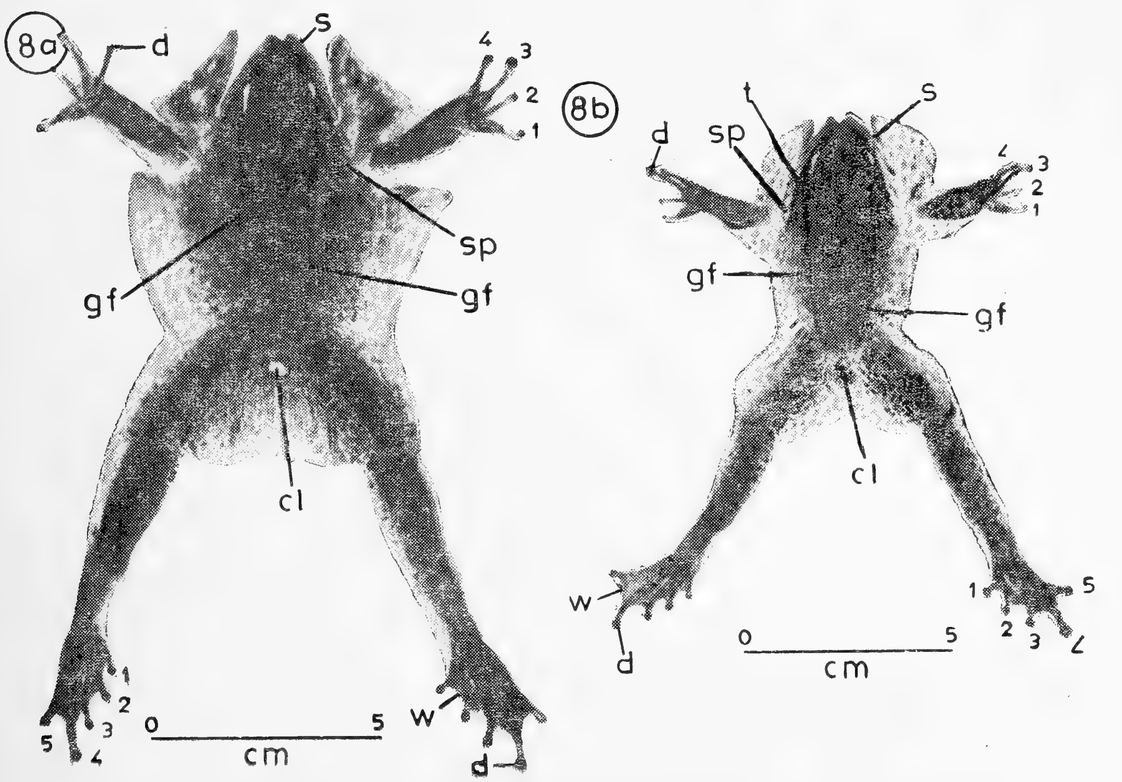


Fig. 8. *Rana temporalis* Bouln. (Fam. Ranidae, Genus Rana, Subgenus *Hylorana*). 8a—male, 8b—female.

Abbreviations: cl, cloacal aperture; d, disc; gf, glandular fold; s, light streak on lip; sp, spot at the angle of jaws; t, tympanum; w, web.

what stout, whether the tips are somewhat rounded or not.

The extent of webbing forms a very important diagnostic character (Daniel 1963). We feel that in our modified method mentioned earlier, this valuable character is beautifully expressed. For example, the webbing is rudimentary in *M. ornata* (Fig. 5) and is rather poor in *B. melanostictus* (Fig. 1) although the degree of webbing is of $\frac{1}{4}$ or of $\frac{1}{2}$ type. In *P. bombayensis* (Figs. 6, 7) the disced toes are not more than 1/3 webbed. In *R. limnocharis* (Fig. 4) the toes are generally half webbed with three phalanges of the 4th toe free. In *R. temporalis* (Fig. 8) the toes are $\frac{3}{4}$ or practically fully webbed and the web typically extends upto the discs of the 3rd and 5th while almost two phalanges of the 4th toe are uncovered by it and hence free. The toes are practically fully webbed in *R. tigerina* (Fig. 2). However, the web does not reach the tip of the 3rd toe and the 5th toe bears an outer fringe of web. This is a feature of forms that are more aquatic in nature. The degree of webbing is typically of the fullest type in *R. cyanophlyctis* (Fig. 3) and the web, as it reaches all the toe-tips shows deep emarginations when toes are spread out.

5. *Other miscellaneous characters*: The extent of attachment or separation of the two external metatarsals (viz., 4th and the 5th) also aids in identification. For example, the outer metatarsals are united in the basal $\frac{1}{2}$ or 1/3 region in *R. limnocharis* (Fig. 4b) or are bound together in *R. breviceps*. They are practically separated upto the base by web in *R. tigerina* (Fig. 2) and in *R. temporalis* (Fig. 8). Glandular folds, streaks, as also the relative size difference in the male and the female are also useful in identification. For example, in *R. temporalis* there are seen two dorso-lateral, glandular folds. Each extending from above the tympanum to cloaca on that side. The two folds enclose between themselves a fairly broad, light-coloured oval patch on the back (Fig. 8b). In the same frog there runs along the border of the upper lip a light, dirty-whitish streak that also posteriorly forms a similar spot near the angle of the jaws (Fig. 8a).

The nature of inner and outer metatarsal tubercles is also useful in identification. For example, the inner metatarsal tubercle is relatively small and obtuse in *R. tigerina* (Fig. 2) but is large, crescentic and shovel-shaped in *R. breviceps.* Both inner and outer metatarsal tubercles are present in *R. limnocharis* and in *M. ornata*. However, the nature of the tubercles is not well retained when the skin is subjected to pressure in a herbarium press. The character, is therefore, not very satisfactorily retained, in general, in this method.

In frogs, in general, the male is smaller in size as compared to the female of the same species, for example, *R. cyanophlyctis* (Fig. 3a, 3b). However, the male is large and with strong fore-limbs, as compared to the female, for example, *R. temporalis* (Figs. 8a, 8b).

Acknowledgements

We are thankful to Mr. J. C. Daniel and Miss S. Isaac, Bombay Natural History Society, Bombay for the help they rendered in identification of the specimens. One of us (SYP) is also thankful to Principal, Modern College, Poona for his encouragement and to Mr. S. M. Katdare, Department of Biology, Modern College, Poona for his help.

References

BOULENGER, G. A. (1920): A monograph of the South Asian, Papuan, and Australian Frogs of the genus Rana. *Rec. Ind. Mus. 20*:1-226.

DANIEL, J. C. (1963): Field Guide to the Amphibians of Western India. Part-1. *J. Bombay nat. Hist. Soc. 60* (2): 415-438.

——— (1963): ibid. Part 2. *J. Bombay nat. Hist. Soc. 60 (3)*: 690-702.

KINCAID, T. (1948): To preserve the colour pattern of the skin in frogs. *Turtox News. 26*: 50-51.

KNUDSEN, J. W. (1966): Biological Techniques. Harper & Row & Weatherhill, N.Y., London, Tokyo.

PARANJAPE, S. Y. AND MULHERKAR, L. (1979): On the survey of the amphibian fauna in and around Poona *J. Univ. Poona* Sc. & Tech. Sec. *52*: 423-434.

——— (1977): A modification to the method for preparing dried skins of Anurans, *British Journal of Herpetology* (Accepted for publication).

A CONTRIBUTION TO THE VASCULAR FLORA OF VENKATAGIRI HILLS AND ENVIRONS[1]

B. Suryanarayana[2]

Floristic information on Venkatagiri Hills (in the Eastern Ghats) and environs is wanting except for rare references in *Flora of the Presidency of Madras* (Gamble 1957). This report covers plants collected during 1969-1971 in the area, and is the first report on the flora of the area and lists 320 plants belonging to 90 families. Among these, 9 are pteridophytes, 247 are dicotyledons and 64 are monocotyledons. Further, *Canscora perfoliata* Lamk. is reported for the first time from the Eastern Ghats of India. *Habenaria digitata* Lindl., *H. hollandiana* Sant. and *Sporobolus piliferus* Kunth are new records for Rayalaseema in Andhra Pradesh.

Introduction

Venkatagiri hills, a part of Veligondla hills in the Eastern Ghats, are situated 15 km from Venkatagiri Town in the West 13° 57′N and 79° 37′E. They are 79 km off the sea coast. The altitude of the hills in the area ranges between 500 m and 1033 m. The hills can be approached only on foot, from Venkatagiri and the journey is strenous. Venkatagiri is a small town, 130 km north-west of Madras and is connected both by rail and road. The Kaivalya river traverses the area and is fed by a small water-falls at Malleswara Kona in the hills. Though the area is rich in vegetation, floristic information is lacking except for stray citations as "Veligondla hills" and "Venkatagiri Drug (Cuddapah)" found in FLORA OF THE PRESIDENCY OF MADRAS (Gamble 1957). Therefore botanical excursions were conducted within a 15 km radius of Venkatagiri which include Ammapalem, Jayampu, Malleswara Kona, Mogallagunta, Palemkota and Venkatagiri hills for two years during 1969 to 1971, covering all the seasons of a year. A number of plants were collected in different stages of their life histories and ample field notes were taken. However this paper lists 320 plants spread over 90 families. Of these 9 are pteridophytes, 247 are dicotyledons and 64 are monocotyledons. The identifications of most of the plants were confirmed at the Botanical Survey of India, Southern Circle, Coimbatore by the author. The specimens are deposited in the Herbarium, Visvodaya College, Venkatagiri Town. But the cyperaceous specimens are stored in the herbarium of the Presidency College, Madras.

Climate: On the whole the weather is rather dry and the temperature reaches even 44°C during the hot period, from March to early June.

Monsoon occurs in two phases. The south-west monsoon, the first phase, occurs between June to September bringing down the temperature. The north-east monsoon is the second phase causing heavy showers, during October-December. The cold weather is between January and February. The annual average rain fall is about 105 cm.

1 Accepted March 1978.

2 Visvodya College, Venkatagiri, Andhra Pradesh.

General pattern of vegetation

After a few showers of rain by about the middle of June, the land is covered by a number of sprouting grasses. *Borreria articularis* (L.f.) Will., *Bulbostylis barbata* (Rottb.) Cl., *Cleome aspera* Koenig, *Hybanthus enneaspermus* (L.) F. Muell., *Indigofera linnaei* Ali, *Tribulus terestris* Linn., are found among grasses. In the second half of monsoon, grasses grow fairly tall. *Apluda mutica* Linn., *Chloris barbata* Sw., *Cymbopogon martinii* (Roxb.) Wats., *Eragrostis* sp., *Heteropogon contortus* (L.) P. Beauv. ex R. & S., *Perotis indica* (L.) O. Kuntze etc. are often found in mixed or pure stands. Among these tall grasses a number of other plants are noticed namely *Ageratum conyzoides* Linn., *Corchorus aestuans* Linn., *Croton bonplandianum* Baill., *Eclipta alba* (L.) Hassk., *Euphorbia hirta* Linn., *Phyllanthus asperulatus* Hutch., *Sida acuta* Burm. f. etc. By the end of the monsoon or a little later most of the monsoon vegetation disappears and those characteristic of the cold season appear. Some of the common ones are *Andrographis echioides* (L.) Nees, *Anisomelis malabaricus* R.Br., *Barleria prionitis* Linn., *Blumea* sp., *Elytraria acaulis* (L.f.) Lindau, *Heliotropium indicum* Linn., *Lepidagathis mitis* Dalz., *Leucas aspera* (Willd.) Sprang., *Orthosiphon pallidus* Royle ex Bth., etc.

The forests are mainly of two types. 1) dry deciduous on the hills and 2) scrub on the plains.

Vegetation of dry deciduous forests: The thick forests in the area are now subjected to significant disturbance by indiscriminate felling and fire operations for the sake of fuel. Therefore there is every danger of these forests being reduced to scrub jungles in course of time. Trees do not seem to reach a good height and are stunted in growth.

The common trees of the forests are: *Anogeissus latifolia* (Roxb.) Wall. ex Bedd., *Erythroxylon monogynum* Roxb., *Hardwickia binata* Roxb., *Lannea coromandelica* (Houtt.) Merr., *Manilkara hexandra* (Roxb.) Dub., *Strychnos nux-vomica* Linn., *Terminalia chebula* Retz. etc.

The following are occasional trees: *Albizzia amara* Boivin, *Dalbergia paniculata* Roxb., *Madhuca logifolia* (Koenig) Macbride, *Spondias pinnata* (L.f.) Kurz., *Vitex altissima* L.f.

Buchanania angustifolia Roxb., *Vitex leucoxylon* Linn.f. etc., are rare.

The hedges along footpaths in the forests are commonly represented by *Barleria prionitis* Linn., *Carissa spinarum* Linn., *Diospyros chloroxylon* Roxb., *Maba buxifolia* (Roxb.) Pers., *Memecylon edule* Roxb., *Meytenus emarginata* (Willd.) Ding Hou, *Tarenna asiatica* (L.) Alston, *Xeromphis spinosa* (Thunb.) Keay, *Zizyphus xylopyrus* (Retz.) Willd.

The following are a few of the common climbers on large shrubs: *Ampelocissus tomentosa* (Heyne ex Roth) Planch., *Dioscorea oppositifolia* Linn., *D. pentaphylla* Linn. var. *linnaei* Pr. & Burk, *Hemidesmus indicus* (L.) Schultes, *Pergularia daemia* (Forsk.) Blatt. & McC. and *Rivea hypocrateriformis* (Lam.) Choisy. etc.

Derris scandens (Roxb.) Bth., *Hugonia mystax* Linn., *Pterolobium indicum* A. Rich., and *Ventilago denticulata* Willd. are occasional lianas noticed on tall trees.

Vegetation of scrub jungles: Scrub jungles in the area are commonly represented by *Acacia nilotica* (L.) Del. subsp. *indica* (Bth.) Brenan, *Bauhinia racemosa* Lamk., *Carmona retusa* (Vahl) Masamune, *Dodonaea viscosa* (L.) Jacq., *Euphorbia trigona* Haw., *Maba buxifolia* Pers., *Meytenus emarginata* (Willd.) Ding Hou, *Plectronia parviflora* Bedd., *Tarenna asiatica* (L.) Alston and *Zizyphus xylopy-*

rus (Retz.) Willd. etc.

Riparian and pond flora: *Alangium salviifolium* (L.f.) Wang., *Allophylus cobbe* (L.) Raeusch., *Flemingia strobilifera* R. Br., *Helicteres isora* Linn., *Homonoia riparia* Lour., *Mallotus philippinensis* (Lamk.) Muell.-Arg., *Pterospermum heyneanum* Wall. etc., form significant components of the vegetation in valleys along the water courses.

In some ponds and water logged areas of the river *Aponogeton natans* (L.) Engler & Krause, *Hydrilla verticillata* Royle, *Ottelia alismoides* (L.) Pers., *Najas minor* All. var. *spinosa* Rendle, *Vallisneria spiralis* Linn., etc., are found in abundance.

On the moist banks of rivers and along the wet margins of temporary ponds *Bacopa monnieri* (L.) Wettstein, *Phyla nodiflora* (L.) Greene form brightly coloured dense mats of vegetation. Along with them several other common and noteworthy plants also are found growing. A few of them are *Alternanthera sessilis* (L.) DC., *Ammannia baccifera* Linn., *A. multiflora* Roxb., *Bulbostylis barbata* (Rottb.) Cl., *Cleome aspera* Koenig, *Commelina diffusa* Burm. f., *Cyperus tenuispica* Steud., *Eriocaulon quinquangulare* Linn., *Ludwigia perennis* Linn., etc. At certain isolated localities *Saccharum spontaneum* Linn., forms a thick hedge along the water course.

In the dry ground of the river-bed and drying temporary ponds *Argemone mexicana* Linn., *Glinus totoides* Linn., *Heliotropium supinum* Linn. and *Solanum surattense* Burm. f. etc., form loose or dense patches. Other common plants are: *Aerva lanata* (L.) Juss., *A. monsoniae* Mart., *Anisomelis malabaricus* R. Br., *Calotropis gigantea* (L.) R. Br., *Cassia auriculata* Linn., *Datura fastuosa* Linn., *Fimbristylis* sp., *Jatropha gossypifolia* Linn., *Leucas aspera* (Willd.) Spreng., *Vitex negundo* Linn., etc.

Vegetation along roadsides: *Aegle marmelos* (L.) Corr., *Albizzia lebbek* (L.f.) Bth., *Azadirachta indica* A. Juss., *Derris indica* (Lam.) Bennett. *Fiscus religiosa* Linn., *Limonia acidissima* Linn., *Sapindus emarginatus* Vahl, *Syzygium cuminii* Skeels., *Thespesia populnea* Cav., etc., are common along roadsides either planted or growing wild.

A number of plants together form thick hedges along roadsides. Among them a few prominent and common ones being, *Carissa carandas* Linn., *Diospyros chloroxylon* Roxb., *Euphorbia trigona* Haw., *Meytenus emarginata* (Willd.) Ding Hou, *Securinega virosa* (Roxb. & Willd.) Pax. & Hoffm., *Tarenna asiatica* (L.) Alston, *Zizyphus oenoplia* Mill. etc., *Anisomelis indica* (L.) O.K., *Barleria prionitis* Linn., and *Cassia auriculata* Linn., are a few other common and attractive plants, by their brightly coloured flowers, among the roadside hedges.

On these hedges many twiners and climbers were noted belonging to the families, Asclepiadaceae, Convolvulaceae, Menispermaceae, Papilionaceae and Vitaceae. Among them the common ones are *Cissus quadrangularis* Linn., *Cocculus hirsutus* (L.) Diels, *Gymnema sylvestre* (Retz.) R. & S., *Pergularia daemia* (Forsk.) Chiov., *Teramnus labialis* Spreng., *Tylophora indica* Merr.

Several herbs are found growing in the undergrowth. e.g., *Aerva lanata* (L.) Juss., *Andrographis echioides* (L.) Nees, *Asystasia gangetica* T. Anders., *Boerhavia diffusa* Linn., *Elytraria acaulis* (L.f.) Lindau, *Hibiscus ovalifolius* (Forsk.) Vahl, *Justicia diffusa* Wild., *Orthosiphon pallidus* Royle ex Bth., *Pavonia zeylanica* Cav.

Vegetation in cultivated fields: From the moist cultivated fields a number of plants were collected. Some of the common and prostrate herbs are *Borreria articularis* (L.f.) F. N.

Will., *Cleome aspera* Koenig, *Hybanthus enneaspermus* (L.) F. Muell., *Indigofera cordifolia*. Heyne ex Roth, *Merremia tridentata* Hallier, *Mollugo nudicaulis* Lam., *Tribulus terrestris* Linn., etc. Several other common but erect plants also were noticed in these fields. To mention a few: cyperaceous plants, *Eclipta alba* (L.) Hassk., *Euphorbia hirta* Linn., *Geniosporum tenuiflorum* (L.) Merr., *Micrococca mercurialis* Bth., *Phyllanthus asperulatus* Hutch., *P. simplex* Retz. etc. After the harvest, from the drying fields several plants were collected. A few of the common ones are: *Achyranthes aspera* Linn., *Cleome viscosa* Linn., *Corchorus aestuans* Linn., *Croton bonplandianum* Baill., *Eclipta alba* (L.) Hassk., *Emilia sonchifolia* (L.) DC., *Heliotropium indicum* Linn., *Leucas aspera* (Willd.) Spreng., *Sida acuta* Burm. f., *Tridax procumbens* Linn. etc.

Plant parasites in the area: *Dendrophthoe falcata* (L.f.) Etting, *Viscum articulatum* Burm. f. are common stem parasites in forests usually found on *Anogeissus latifolius* (Roxb.) Wall. ex Bedd. and *Hardwickia binata* Roxb., *Cassytha filiformis* Linn., is another common twinning stem parasite in scrub jungles noticed on *Carissa spinarum* DC., *Striga angustifolia* (Don) Saldanha, is a frequent root parasite on grasses in the area.

Enumeration of plants

The plants are enumerated in accordance with Bentham and Hooker's system of classification with some delimitations of families according to Hutchinson (1960). The name of the plant is followed by a note on relative abundance, flower colour, flowering and fruiting time (Fls., Frts.) and field numbers. All the field numbers are of Suryanarayana. Where no number is stated, name of the collector is given. The nomenclature adopted here has, as far as possible, been brought upto date in the light of current literature on the subject.

PTERIDOPHYTES

Psilotaceae

Psilotum triquetrum Sw.

Rare on moist rocks covered by humus, under shade. December, 1970. 3982.

Selaginellaceae

Selaginella barbata Spring.

Occasional, but forming dense green carpets in moist humus soil along with *Anthoceros himalayensis* L. Strobili December, 1970. 3537.

Isoetaceae

Isoetes coromandelina Linn.

Rare among grasses. Sori December, 1969. 3839.

Marsileaceae

Marsilea quadrifolia Linn.

Common and abundant in temporary ponds. August, 1969. 3645.

Adiantaceae

Adiantum caudatum Linn.

Common. Sori December, 1969, 1970. 3665, 3950.

Gymnogrammaceae

Hemionites arifolia (Burm. f.) Moore

Common. Sori December, 1969. 3664.

Pteridaceae

Actinopteris radiata (Sw.) Link

Occasional under the shade of rocks. Sori

December, 1970. No number, D. V. Subbaiah.

Pteris geranifolia Raddi

Occasional under the shade of moist rocks. Sori December, 1970. 3660.

DAVALLIACEAE

Nephrolepis cordifolia (L.) Presl.

Occasional in forests. Sori December, 1970. 3945.

DICOTYLEDONS

RANUNCULACEAE

Naravelia zeylanica (L.) DC.

Rare. A gregarious climber in thick forests. Frts. December, 1970. 3892.

MENISPERMACEAE

Cissampelos pareira Linn.

Occasional twiners on hedges. Flowers small green. Fls. December, 1970. 3995.

Cocculus hirsutus (L.) Diels

An occasional twiner. Flowers small, greenish. Fls. June, 1969. 3324.

Pachygone zeylanica (Gaertn.) Sant. & Wagh.

Occasional twiners. Flowers small green. Fls. December, 1970. 3921.

PAPAVERACEAE

Argemone mexicana Linn.

Common in waste dry places. Flowers yellow. Fls. and Frts. February, 1969. 3558.

BRASSICACEAE

Brassica nigra (L.) Koch.

Common in humus covered waste places. Flowers yellow. Fls. and Frts. November, 1969. No number, D. V. Subbaiah.

CAPPARACEAE

Capparis zeylanica Linn.

Occasional on hedges. Frts. May, 1969. 3225.

Crataeva nurvala Buch.-Ham.

Rare. Frts. May, 1969. 3201.

CLEOMACEAE

Cleome aspera Koenig

Common. Flowers yellow. Fls. May, 1969. 3287.

C. gynandra Linn.

Occasional in waste places. Flowers white. Fls. and Frts. November, 1970. 3540.

C. viscosa Linn.

Common. Flowers yellow. Fls. and Frts. October, 1970. 4133.

VIOLACEAE

Hybanthus enneaspermus (L.) F. Muell.

Common. Flowers purple. Fls. and Frts. May, 1969. 3288.

FLACOURTIACEAE

Flacourtia indica (Burm.f.) Merr.

Common. Flowers White. Fls. and Frts. December, 1969, 1970. 3628, 3855.

CARYOPHYLLACEAE

Polycarpaea corymbosa (L.) Lam.

Common in grasslands. Flowers pink. Fls. and Frts. May and November, 1969. 3291, 3495.

PORTULACACEAE

Portulaca cleracea Linn.

A common weed in moist fields. Flowers yellow. Fls. and Frts. October, 1970. 3541.

MALVACEAE

Abutilon indicum (L.) Sweet

Common and abundant in mixed stands. Flowers yellow. Fls. and Frts. December, 1970. 3542.

Decaschitia crotonifolia Wt. & Arn.

Common on hill slopes. Flowers large, yellow. December, 1969, 1970. 3619, 3951, 4170.

Gossypium herbaceum Linn.

Planted. Flowers yellow. Fls. February, 1970. 4015.

Hibiscus ovalifolius (Forsk.) Vahl

Common in the undergrowth of forests. Flowers white. Fls. and Frts. December, 1970. 3934.

Pavonia zeylanica Cav.

Common. Flowers bright rose. Fls. and Frts. December, 1970. 3860, 3955.

Sida acuta Burm. f.

Common. Flowers yellow. Fls. and Frts. December, 1970. 4128.

S. cordifolia Linn.

Common. Flowers. yellow Fls. and Frts. December, 1970. 3899.

Thespesia populnea Cav.

Planted. Flowers yellow with a purple centre. Fls. June, 1969. 3234, 3393.

STERCULIACEAE

Byettneria herbacea Roxb.

Common on hill slopes among tall grasses. Fls. and Frts. December, 1970. 4109, 4151.

Helicteres isora Linn.

Common in forests. Flowers red. Fls. November. Frts. December, 1969, 1970. 3625, 3643, 4144, 4160.

Melhania incana Heyne ex Wt. & Arn.

Rare in the forests of Jayampu. Fls. and Frts. December, 1970. 3871.

Melochia corchorifolia Linn.

Occasional. Flowers purple. Fls. and Frts. December, 1970. 3830.

Pterospermum heyneanum Wall.

Occasional in thick forests. Flowers not seen. Frts. December, 1969. 3614.

Waltheria indica Linn.

Occasional. Flowers yellow. Fls. and Frts. December, 1970. 3858.

TILIACEAE

Corchorus aestuans Linn.

A common weed. Flowers yellow. Fls. and Frts. December, 1970. 3902.

C. olitorius Linn.

Common on earth bunds of the cultivated fields. Flowers yellow. Fls. November, 1969. Frts. December, 1970. 3483, 3998.

Grewia hirsuta Vahl

Occasional. Frts. December, 1970. 3952.

G. rhamnifolia Heyne ex Roth

Occasional. Frts. December, 1969, 1970. 3618, 3881.

Triumfetta pentandra A. Rich.

Common in the undergrowth of forests. Flowers yellow. Fls. and Frts. December, 1969, 1970. 3613, 3944.

LINACEAE

Hugonia mystax Linn.

Occasional in the forests. This specimen matches with the herbarium sheets of Madras Herbarium, BSI, Coimbatore. But in the absence of flowers or fruits the identification is provisional. December, 1970. 3875.

ERYTHROXYLACEAE

Erythroxylon monogynum Roxb.

A common tree in forests. Fls. and Frts. November, December, 1969, 1970. 3469, 3941.

ZYGOPHYLLACEAE

Tribulus terrestris Linn.
Common. Flowers yellow. Fls. and Frts. November, 1969. 3515.

BALSAMINACEAE

Impatiens balsamina Linn.
Rare but abundant in pure stands at Malleswara Kona. Flowers purple. Fls. and Frts. December, 1970. 3904.

RUTACEAE

Aegle marmelos (L.) Corr.
Occasional in forests and near villages. Frts. November, 1969. 3601.

Glycosmis cochinchinensis (Lour.) Pierre ex Engler.
Common in forests. Fls. (buds), December, 1970. 3802.

Limonia acidissima Linn.
Planted. Frts. May, June, 1969. 3267, 3390.

MELIACEAE

Azadirachta indica A. Juss.
Common. Frts. June, 1969. 3391.

CELASTRACEAE

Elaeodendron roxburghii Wt. & Arn.
Common. The plants are very much stunted when growing in scrub jungles. Flowers and fruits not noticed but the specimens match with the herbarium sheets at Madras Herbarium, BSI, Coimbatore. Therefore identification is tentative. 1970. 3979.

Meytenus emarginata (Willd.) Ding Hou
Common in scrub jungles. Flowers white. Fls. November, 1970. 3808, 3864. Frts. June, 1969. 3334

RHAMNACEAE

Scutia circumcissa (L.f.) Druce
An occasional armed shrub in the scrub jungles. Flowers small, greenish-white. Fls. November, 1970. 3385, 3791.

Ventilago denticulata Willd.
Rare, but a gregarious climber. Flowers pale green. Fls. December, 1970. 3924, 4169.

Zizyphus mauritiana Lam.
Occasional. Flowers pale white. Fls. November, 1969. 3543.

Z. oenoplia Mill.
Common in hedges. Frts. December, 1970. 3876.

Z. xylopyrus (Retz.) Willd.
Common in forests. Frts. December, 1970. 3886, 4148.

VITACEAE

Ampelocissus tomentosa (Heyne ex Roth) Planch.
Common. Flowers scarlet. Fls. and Frts. December, 1970. 3938, 3974.

Cissus quadrangularis Linn.
Common in plains, straggling on shrubs. Flowers red. Fls. and Frts. May, 1969. 3209, 3259.

C. vitiginea Linn.
Occasional on hedges. Flowers small, greenish. Fls. and Frts. June, 1969. 3356.

Leea indica (Burm.f.) Merrill.
Rare in ravines. Frts. December, 1970. 3918.

SAPINDACEAE

Allophylus cobbe (L.) Raeusch.
Common. Flowers small, white. Fls. November, Frts. December, 1969, 1970. 3612, 3795, 3853, 3932.

Cardiospermum canescens Wall.
Rare, a gregarious twiner on large shrubs.

Flowers white. Fls. and Frts. December, 1970. 3965.

C. halicacabum Linn.

Rare on hedges near villages. Flowers white. Fls. May, 1969. 3211, 3297.

Dodonaea viscosa (Linn.) Jacq.

Common in scrub jungles. Flowers purplish-yellow. Fls. November, Frts. December, 1969. 3279, 3407, 3467.

Sapindus emarginatus Vahl

Occasional in forests, sometimes planted in villages. Fls. December, Frts. June, 1969, 1970. 3387, 3882.

ANACARDIACEAE

Anacardium occidentale Linn.

Planted. Flowers red. Fls. January, 1969. No number, D. V. Subbaiah.

Buchanania angustifolia Roxb.

Rare. Flowers not seen. Frts. December, 1970. 4141.

Lannea coromandelica (Houtt.) Merr.

Common. Flowers greenish-yellow. Fls. December, 1969, 1970. 3641, 3928.

Mangifera indica Linn.

One tree near the water fall at Malleswara Kona; planted elsewhere. December, 1970. 3991.

Spondias pinnata (L.f.) Kurz.

Occasional in forest. Vegetative. December, 1970. 3915.

PAPILIONACEAE

Abrus precatorius Linn.

Occasional. Frts. December, 1970. 3916.

Aeschynomene indica Linn.

Common. Flowers yellow. Fls. and Frts. December, 1970. 3846, 4119.

Arachis hypogaea Willd.

Probably an escape from cultivation. Flowers yellow. Fls. and Frts. January, 1970. 3999.

Butea monosperma (Lam.) Taub.

Occasional. The trees are very stunted and do not attain more than 3 metres height. Flowering not observed in the area, but reddish-orange flowers were noticed in the forest near Kurnool. Fls. February, 1973. 3207.

Canavalia gladiata (Jacq.) DC.

Occasional. Flowers purple but turning blue with age. Fls. and Frts. December, 1970. 3983.

Crotalaria juncea Linn.

Occasional. Flowers yellow. Fls. and Frts. January, 1970. 4122.

C. madurensis Wt.

Rare. Flowers yellow. Fls. January, 1970. 4166.

C. medicaginea Lamk.

Common. Flowers yellow. Fls. and Frts. December, 1970. 3879, 3947, 4147.

C. retusa Linn.

Occasional. Frts. January, 1970. 4120.

C. verrucosa Linn.

Common. Flowers blue. Fls. and Frts. December, 1970. 3879, 3947, 4147.

Dalbergia paniculata Roxb.

An occasional tree in the forest. Frts. December, 1970. 3545.

Derris indica (Lam.) Bennett

Common, but usually planted for shade. Flowers bright purple. Fls. and Frts. June, 1969. 3319, 3388.

D. scandens Bth.

Rare. Frts. November, 1970. 4111.

Desmodium pulchellum (L.) Bth.

Common and abundant at the foot of hills. Flowers white. Fls. and Frts. December, 1969, 1970. 3622, 3912, 4172.

D. velutinum (Willd.) DC.

Common at the foot of hills. Flowers purple. Fls. and Frts. December, 1970. 3907.

D. triflorum (L.) DC.

Common. Flowers purple. Fls. December,

1970. 3920.

Erythrina variegata Linn. var. **orientalis** (L.) Merr.

A favourite hedge plant in villages. Flowers red and showy. Fls. February, 1969. 3546.

Gliricidia sepium (Jacq.) Walp.

Planted as a hedge plant. Flowers bright rose. Fls. January, 1969. No number, D. V. Subbaiah.

Heylandia latebrosa DC.

Occasional. Flowers yellow. Fls. and Frts. December, 1970. 3851, 4161.

Indigofera astragalina DC.

Rare. Frts. December, 1970. 3993.

I. cordifolia Heyne ex Roth

Common. Flowers red. Fls. November, 1970. 3794.

I. linnaei Ali

Common. Flowers Red. Fls. and Frts. June, 1969. 3312.

Ormocarpum sennoides DC.

Rare. Flowers yellow. Fls. and Frts. November, 1969. 3520, 3600.

Pseudarthria viscida Wt. & Arn.

Occasional. Flowers yellow. Fls. and Frts. December, 1970. 3911.

Rhynchosia sauveolens DC.

Rare. Flowers yellow. Fls. and Frts. December, 1970. '3986.

Tephrosia tinctoria Pers.

Rare. Frts. December; 1970. 3903.

Teramnus labialis Spreng.

A common twiner on bushes. Flowers yellow. Fls. and Frts. December, 1970. 3945.

Caesalpiniaceae

Bauhinia racemosa Lamk.

Common in scrub jungle. Very much stunted, some times even adpressed to the ground when growing in the plains. Flowers yellow. Fls. October-November, Frts. February-June, 1969. 3200, 3412.

Cassia absus Linn.

Occasional during post monsoon. Flowers yellow. Fls. and Frts. November-December, 1969. 3548.

C. auriculata Linn.

Common and abundant. Flowers yellow. Fls. January-June, 1969. 3222, 3392, 3462.

C. fistula Linn.

Occasional in forests. Frts. December, 1970. 3812.

C. montana Heyne ex Roth

Occasional in ravines. Flowers yellow. Fls. and Frts. December, 1970. 3940, 4149.

C. occidentalis Linn.

Common in waste land. Flowers yellow. Fls. and Frts. January, 1969. 3549.

C. tora Linn.

Common. Flowers yellow. Fls. and Frts. December, 1970. 3368.

Hardwickia binata Roxb.

A common tree in forests. Fls. November, 1969. 3523.

Pterolobium indicum A. Rich.

Common. An armed straggler. Frts. November, 1969. 3529.

Tamarindus indica Linn.

Common near villages. Flowers reddish. Fls. May-June, Frts. November, 1969. No number, D. V. Subbaiah.

Mimosaceae

Acasia caesia Willd.

An occasional armed climber. Flowers in white heads. Fls. November, 1969. 3583.

A. ferruginea DC.

Common. Frts. December, 1970. 3883.

A. latronum Willd.

Common in scrub jungles. Fls. December, 1970. 4131.

A. nilotica (L.) Del. subsp. **indica** (Bth.) Brenan

Common in scrub jungles. Flowers yellow. Fls. June, 1969. 3217, 3300.

A. torta (Roxb.) Craib.

Common. Flowers small in heads. Fls. and Frts. December, 1970. 3960.

Albizzia amara Boivin

Occasional in forests. Frts. December, 1969. 3584.

A. lebbek (L.) Bth.

Occasional. It is also planted as avenue tree. Fls. January, Frts. May, 1969. 3257.

Dichrostachys cinerea Wt. & Arn.

Occasional in scrub jungle. Spikes yellow-purple. Fls. November, Frts. December, 1969, 1970. 3229, 3527, 3884.

Leucaena leucocephala (Lam.) de Wit.

Occasional in villages. Frts. May, 1969. 3248, 3383.

Prosopis cineraria (L.) Druce

Common and abundant in waste land around inhabitations. Fls. December, Frts. May, 1969. 3230, 3335, 3399.

COMBRETACEAE

Anogeissus latifolius Bedd.

Common. Flowers small greenish-yellow. Fls. and Frts. December, 1970. 3914, 4165.

Terminalia bellerica (Gaertn.) Roxb.

An occasional lofty tree in forests. Frts. December, 1970. 3880.

T. chebula Retz.

Common on hill slopes at Malleswara Kona. Frts. December, 1969. 3447.

MYRTACEAE

Syzygium cuminii Skeels

Common. Flowers yellowish-white. Fls. March, Frts. June, 1969, 1970. 3395, 3948.

MELASTOMACEAE

Memecylon edule Roxb.

Common. Flowers attractive blue. Fls. sparsely flowered in December in the present area. But elsewhere gregarious flowering is observed in July (1973). Frts. November, 1970. 3528, 3642.

LYTHRACEAE

Ammannia baccifera Linn.

Common in moist places. Flowers red. Fls. and Frts. February, 1970. 4010.

A. multiflora Roxb.

Common in wet fields. Flowers red. Fls. and Frts. December, 1970. 3825.

Rotala densiflora (Roth) Koehne

Occasional but found in pure or mixed stands. Flowers red. Fls. and Frts. December, 1970. 3828.

ONAGRACEAE

Ludwigia perennis Linn.

Common in wet fields. Flowers yellow. Fls. and Frts. December, 1970. 3824.

CUCURBITACEAE

Citrullus lanatus (Thunb.) Monsf.

An occasional creeper in river bed. Frts. May, 1969. 3280.

Solena heterophylla Lour.

Occasional. Male flowers creamy-white, Fls. May, 1969. 3238.

Trichosanthes bracteata (Lam.) Voigt

Occasional. Frts. August, 1969, 1970. 3608, 4132.

CACTACEAE

Opuntia coccinellifera Mill.

Occasional in scrub jungles. Flowers red

and attractive. Fls. November, 1969. 3361.

O. elatior Mill.

Common. Flowers yellow. Fls. October, 1970. No number, D. V. Subbaiah.

MOLLUGINACEAE

Glinus lotoides Linn.

Common. Frts. May-June, 1969. 3242. 3310.

G. oppositifolius (L.) A. DC.

Common, flowers white. Fls. June, Frts. September, 1969, 1970. 3311, 4138.

Mollugo nudicaulis Lam.

Common. Flowers white. Fls. June, Frts. September, 1969, 1970. 3315, 4139.

AIZOACEAE

Trianthema portulacastrum Linn.

Common. Flowers bright purple. Fls. June, 1969. 3363.

ALANGIACEAE

Alangium salvifolium (L.f.) Wang.

Common in the hedges around irrigation tanks. Flowering was not noticed inspite of intense search throughout the year in the present area. Therefore identification is provisional. 1969, 1970. 3368, 3410, 3931.

RUBIACEAE

Borreria articularis (L.f.) F.N. Will.

Common. Flowers purple. Fls. November, 1969. 3587.

Canthium dicoccum (Gaertn.) T. & B.

Occasional, flowers white. Fls. November, 1969. 3477.

Gardenia lucida Roxb.

Occasional, flowers large, white but turning yellow with age. Fls. and Frts. December, 1970. 3956, 4140.

Guetarda speciosa Linn.

One tree is found, probably planted. Flowers white. Fls. January, 1970. 4112.

Knoxia sumatrensis (Retz.) DC.

Occasional in the undergrowth. Flowers white with purplish tinge. December, 1970. 3996.

Morinda tinctoria Roxb.

Planted in private compounds for fragrant white flowers. Fls. January, 1970. 4158.

Oldenlandia corymbosa Linn.

Common. Flowers white. Fls. and Frts. More or less throughout the year, 1969, 1970. 3282, 3317, 3405, 3862.

O. affinis (R. & S.) DC.

Occasional flowers white. Fls. and Frts. December, 1970. 3977.

Plectronia parviflora Bedd.

Common. Flowers white. Fls. May-June, Frts. November-December, 1969, 1970. 3301, 3332, 3379, 3855A.

Tarenna asiatica (L.) Alston

Common in forests and scrub jungles. Flowers white. Fls. December, Frts. May, 1969, 1970. 3210, 3396, 3863, 3877.

Xeromphis spinosa (Thunb.) Keay

Common. Flowers white but turning yellow with age. Fls. June, Frts. December, 1969, 1970. 3334, 3935.

ASTERACEAE

Ageratum conyzoides Linn.

Common. Heads white. Fls. and Frts. December, 1970. 3909.

Bidens biternata (Lour.) Merr. & Sherff.

Common either in mixed or pure stands. Heads yellow, November, 1969. No number, D. V. Subbaiah.

Echinops echinatus Roxb.

Rare. Found a few plants at Jayampu. Flowers white. Heads September, 1970. 3815.

Eclipta alba (L.) Hassk.
A common weed. Heads white, November, 1970. 3552.

Emilia sonchifolia (L.) DC.
Common. Heads purple, December, 1969. 3869.

Glossocardia bosvallea (L.f.) DC.
Common. Heads yellow, November, 1969. 3463.

Tridax procumbens Linn.
Common and abundant. Heads yellow, May-June, 1969. 3320, 3412.

Vernonia albicans DC.
Common. Heads purple, December, 1970. 3961.

V. cinerea (L.) Less.
Common. Heads purple, December, 1970. No number. D. V. Subbaiah.

Vicoa indica (Willd.) DC.
Occasional. Heads yellow, December, 1970. 3816.

Plumbaginaceae

Plumbago zeylanica Linn.
Rare, collected from the roadside bushes on way to Railway Station. Flowers white. Fls. and Frts. January, 1969. 3554.

Sapotaceae

Madhuca longifolia (Koenig.) Macbride
Occasional. Flowers light-yellow, succulent. Fls. May, 1969. 3232.

Manilkara hexandra (Roxb.) Dub.
Common. Flowers white, scented. Fls. December, 1969. 3526, 3638.

Ebenaceae

Diospyros chloroxylon Roxb.
Common, often found in hedges. Flowers white. Fls. May-June, 1969, 3220, 3306.

D. melanoxylon Roxb.
Occasional in scrub jungles. Identification is provisional in the absence of flowers and fruits. May, 1969. 3205.

Maba buxifolia Pers.
Common. Frts. May-June, 1969. 3206, 3381.

Oleaceae

Jasminum auriculatum Vahl
Common in bushes. Flowers white. Fls. and Frts. November-December, 1969, 1970. 3531, 3971.

Apocynaceae

Carissa carandas Linn.
Common in hedges. Flowers white. Fls. May, 1969. 3252.

C. spinarum DC.
Common. Flowers white. Fls. June, 1969. 3305.

Catharanthus pusillus (Murr.) G. Don
Rare in cultivated fields as a weed. Flowers white. Fls. and Frts. May, 1969. 3241.

Wrightia tinctoria R. Br.
Occasional in thick forests. Frts. December, 1970. 3814, 3906.

Thevetia peruviana (Pers.) Merr.
Planted. Flowers yellow. Fls. May, 1969. 3221.

Asclepiadaceae

Calotropis gigantea (L.) R. Br.
Common in wasteland. Flowers bluish. Fls. November, 1969. 3536.

Caralluma adscendens (Roxb.) R. Br.
Common in large bushes. Flowers dark purple. Fls. January, Frts. July, 1970. 4107, 4124.

Ceropegia bulbosa Roxb.
Occasional in the bushes along the Railway Station Road. Flowers greenish-yellow. Fls. December, 1969. 3555.

Gymnema sylvestre (Retz.) R. Br. ex Schult.
Common. Flowers yellowish-green. Fls. November, 1969. Frts. December, 1970. 3514, 3811.

Hemidesmus indicus (L.) Schult
Common, very variable plant. Flowers yellowish-green. Fls. and Frts. December, 1970. 3865, 3922, 4264.

Pergularia daemia (Forsk.) Chiov.
Common in hedges. Frts. February, 1970. 4013.

Sarcostemma brevistigma Wt. & Arn.
Common, a leafless straggler. Flowers yellowish. Fls. November-December, 1969, 1970. 3487, 3968.

Secamone emetica R. Br.
Rare, a gregarious climber on large shrubs. Flowers pretty, yellow, Fls. November, 1969. 3461.

Tylophora indica (Burm. f.) Merr.
Common. Flowers yellowish. Fls. May-June, 1969, 1970. 3270, 3322, 4130.

Loganiaceae

Strychnos nux-vomica Linn.
Common in forests. Frts. November, 1969. 3204, 3521.

Gentianaceae

Canscora perfoliata Lam.
Rare in moist, cool and shady places. Flowers white. Fls. and Frts. December, 1970. 3901.

Enicostemma hyssopifolium (Willd.) Verd.
Occasional. Flowers white. Fls. December, 1970. 3831.

Ehretiaceae

Carmona retusa (Vahl) Masamune
Common in scrub jungles. Flowers white. Fls. June, 1969. 3289, 3400.

Cordia obliqua Willd.
Occasional on tank bunds near villages. Flowers white. Fls. June, 1969. 3413.

Boraginaceae

Heliotropium indicum Linn.
Common. Flowers purplish. Fls. and Frts. November, 1969. 3603.

H. supinum Linn.
Abundant in dried tanks. Flowers white. Fls. and Frts. May, 1969. 3246.

Convolvulaceae

Evolvulus alsinoides Linn.
Common in grasslands. Flowers blue. Fls. and Frts. November, 1969. 3485.

Ipomoea muricata (L.) Jacq.
An occasional climber with large purple flowers. Fls. December, 1970. 3793.

I. obscura (L.) Ker.-Gawl.
Occasional on hedges. Flowers white. Fls. December, 1970. 3985.

Merremia tridentata Hallier
Common. Flowers yellow. Fls. and Frts. June, 1969. 3281.

Rivea hypocrateriformis (Lam.) Choisy.
Common. Flowers white. Fls. and Frts. November-December, 1969, 1970. 3502, 3531, 3976.

Solanaceae

Datura fastuosa Linn.
Occasional. Flowers white. Fls. and Frts. November, 1969. 3821.

Solanum nigrum Linn.

Common in waste places. Flowers small and white. Fls. and Frts. December, 1969. 3556.

S. surattense Burm.f.

Occasional in dry places. Flowers violet. Fls. and Frts. June, 1969. 3403.

SCROPHULARIACEAE

Bacopa monnieri (L.) Wettstein

Abundant in pure stands in moist soil. Flowers bluish-purple or almost white. Fls. May, 1969. 3234.

Lindernia hyssopoides (L.) Haines

Common. Flowers purple. Fls. and Frts. December, 1970. 3829.

L. oppositifolia (Don) Mukerjee

Common. Flowers bright purple. Fls. December, 1970. 3827.

Limnophila indica (L.) Druce

Common. Flowers turbid white. Fls. December, 1970. 3857.

Striga angustifolia (Don) Saldanha

Common, but scattered in pasture lands. Flowers white. Fls. November-December, 1969, 1970. 3496, 3798, 3849.

S. lutea Lour. var. **lutea**

Rare, found among grasses on hill slopes. Flowers yellow. Fls. December, 1970. 4152.

MARTINIACEAE

Martynia annua Linn.

Occasional in the forests near Railway Station. Flowers purple. Fls. January, 1970. 3557.

PEDALIACEAE

Sesamum indicum Linn.

Solitary in waste places. Probably an escape from cultivation. Frts. December, 1970. 4134.

ACANTHACEAE

Adhatoda vasica Nees

Occasional in hedges near villages. Flowers white. Fls. and Frts. February, 1971. 4002.

Androagraphis echioides (L.) Nees

Common. Flowers purple. Fls. and Frts. May, 1969. 3266.

A. paniculata (Burm.f.) Wall. ex Nees

Common. Flowers purple. Fls. and Frts. December, 1970. 3870.

Asystasia gangetica T. And.

Common. Flowers white. Fls. and Frts. February, 1971. 4106.

Barleria prionitis Linn.

Common among bushes. Flowers yellow. Fls. November-December, 1969, 1970. 3474, 3873, 3936.

Blepharis boerhaaviaefolia Pers.

Common in the undergrowth. Flowers turbid white. Fls. and Frts. December, 1970. 3962.

Elytraria acaulis (L. f.) Lindau

Common. Flowers white. Fls. May, 1969. 3293.

Justicia diffusa Willd.

Common. Flowers purple. Fls. and Frts. December, 1970. 4159.

J. prostrata (Roxb. ex C.B.C1.) Gamble

Occasional. Flowers purple. Fls. and Frts. May, 1969. 3296.

J. glauca Rottl.

Common. Flowers purple. Fls. and Frts. December, 1970. 3964, 4105.

Lepidagathis mitis Dalz.

Common in hard soil. Flowers purple. Fls. and Frts. December, 1969. 3856, 3913.

VERBENACEAE

Gmelina asiatica Linn.

Common in scrub jungles. Flowers yellow. Pendulous. Fls. May-June, 1969, 1970. 3226, 4132.

Lantana camara Linn. var. **aculeata** (L.) Moldenke

Common and abundant. Flowers purple and white. Fls. and Frts. May and November, 1969. 3290, 3505.

Phyla nodiflora (L.) Greene

Common in large patches in moist soil. Flowers white with purple streak. Fls. and Frts. November, 1970. 3799.

Tectona grandis Linn. f.

A few trees at Malleswara Kona in lead. December, 1970. 3564.

Vitex altissima Linn.

Occasional in forests. Flowers white. Fls. November, 1970. 4144.

V. leucoxylon Linn. f.

Rare. In the absence of reproductive parts identification is provisional. December. 1970. 3927.

V. negundo Linn.

Common. Flowers bluish-mauve. Fls. May, 1969. 3235, 3273.

LAMIACEAE

Anisochilus carnosus Wall.

Occasional, Flowers light purple. Fls. and Frts. December, 1970. 3905.

Anisomelis indica (L.) O. Kuntze

Common in hedges. Fls. purple. Fls. and Frts. December, 1969, 1970. 3269, 3621, 3847.

A. malabaricus R. Br.

Common. Flowers rosy-purple. Fls. and Frts. December-February, 1969, 1970. 3269, 3852, 3926, 4167.

Geniosporum tenuiflorum (L.) Merr.

Occasional along earth bunds in cultivated fields. Flowers small, purple. Fls. and Frts. February, 1970. 4004.

Leonotis nepetaefolia R. Br.

Occasional. Flowers orange-red. Fls. and Frts. January-March, 1970. 4012, 4104.

Leucas aspera (Willd.) Spreng.

Common. Flowers white. Fls. and Frts. November, 1969. 3504.

L. biflora R. Br.

Occasional. Flowers white. Fls. and Frts. November-December, 1969, 1970. 3506, 3949.

L. lavandulifolia Rees.

Common on hill slopes. Flowers white. Fls. June, 1969. 3342.

Ocimum americanum Linn.

Common. Flowers purplish-white. Fls. and Frts. February and June, 1969, 1970. 3408, 4009.

Orthosiphon pallidus Royle ex Bth.

Common. Flowers purplish white. Fls. and Frts. November, 1969. 3500.

NYCTAGINACEAE

Boerhaavia diffusa Linn.

Common. Flowers purple. Fls. and Frts. June, 1969. 3316.

AMARANTACEAE

Achyranthes aspera Linn.

Common. Flowers small, dry-white. Fls. and Frts. January, 1969. No number. D. V. Subbaiah.

Aerva lanata (L.) Juss.

Common. Flowers white in wooly spikes. Fls. and Frts. December, 1970. 3866.

A. monsoniae Mart.

Common in dry sandy soil. Spikes pale pink. Fls. and Frts. December, 1970. 3910.

Alternanthera sessilis (L.) DC.

Common and abundant in moist margins of temporary ponds and puddles. Flowers white. Fls. and Frts. November, 1969. 3559.

Digera alternifolia (L.) Aschers

A common weed. Flowers purple. Fls. and Frts. February, 1970. 4008.

Pupalia lappacea (L.) Juss.

Occasional. Fruiting. Frts. December, 1970. 3969.

Aristolochiaceae

Aristolochia bracteolata Lam.

Common in the dry soil. Flowers deep purple. Fls. February, 1970. Frts. May, 1969. 3224, 3259, 4014.

Lauraceae

Cassytha filiformis Linn.

Common stem parasite in scrub jungles. Flowers white. January, 1971. 3224, 3259, 4014.

Loranthaceae

Dendrophthoe falcata (L. f.) Etting var. **coccinea** (Talb.) Sant.

Common. Flowers red. Fls. December, 1970. 3878, 3897.

Viscum articulatum Burm f.

Occasional. Flowers small, green. Fls. and Frts. December, 1970. 4118, 4155.

Euphorbiaceae

Acalypha indica Linn.

Common and abundant in waste places. Fls. small. Fls. and Frts. November-January, 1970. 3561.

Bridelia retusa (L.) Spreng.

Rare in forests. Frts. November, 1970. 4154.

Cleistanthus collinus (Roxb.) Bth. & Hook.

Occasional in forests. Frts. February, 1970. 3868, 4126.

Croton bonplandianum Baill.

Common and abundant in waste places. Male flowers white, females green. Fls. and Frts. November-January, 1969, 1970. 3659.

Euphorbia hirta Linn.

Common. Flowers minute, greenish. Fls. and Frts. May, 1969. 3256.

E. serpens H.B.K.

Common. Flowers minute, green. Fls. and Frts. May, 1969. 3245.

E. tirucalli Linn.

Occasional in hedges. Frts. (dried) June, 1969. 3327.

E. trigona Haw.

Common and abundant in scrub jungles. Flowers red. Fls. January, 1970. 3414, 4114.

Hemicyclia sepiaria Wt. & Arn.

Occasional in scrub jungles. Flowers small white. Fls. and Frts. December, 1970. 3562.

Homonoia riparia Lour.

Common at Malleswara Kona. Flowers red. Fls. and Frts. December, 1969. 3946, 4156.

Jatropha gossypifolia Linn.

Common in scrub jungles. Flowers red. Fls. and Frts. May, 1969. 3216, 4136.

Mallotus philippinensis (Lam.) Muell.-Arg.

Common at Malleswara Kona. Fruits with red tomentum. Frts. December, 1969. 3616.

Micrococca mercurialis Bth.

Common in fields. Flowers minute. Fls. February, 1970. 4113.

Phyllanthus asperulatus Hutch.

Common. Flowers small, greenish. Fls. and Frts. November-February, 1969, 1970. 3568.

P. debelis Ham.

Common. Flowers small, pale green. Fls. and Frts. December-February, 1970, 1971. 3997, 4116.

P. maderaspatensis Linn.

Common. Flowers purplish-white. Fls. and Frts. January, 1971. 4117, 4144.

P. simplex Retz.

Common. Flowers small, greenish-white. Fls. and Frts. November, 1969. 3466.

Ricinus communis Linn.

Occasional in waste land. Flowers, yellowish-white. Fls. February, 1971. 4018.

Sebastiania chamaelea Muell.-Arg.

An occasional weed in cultivated fields. Flowers small, white. Fls. and Frts. January, 1970. 3810.

Securinega virosa (Roxb. ex Willd.) Pax. & Hoffm.

Common. Fruits fleshy and white. Frts. November, 1969. 3331, 3530.

Tragia involucrata Linn.

Occasional among bushes. Flowers minute, greenish. Fls. May, 1969. 3260.

Trewia nudiflora Linn.

Rare in hedges. Flowers small, greenish. Fls. December, 1970. 3834.

Moraceae

Ficus gibbosa Bl. var. **parasitica** King.

Rare in forests. Fls. and Frts. December, 1969. 3978.

F. hispida Linn. f.

Occasional near villages. Frts. May, 1969. 3208, 3271.

F. racemosa Linn.

Occasional in villages. Vegetative, May, 1969. 3292.

F. religiosa Linn.

Common. Fruits red. March-April, 1969. 3564.

MONOCOTYLEDONS

Hydrocharitaceae

Hydrilla verticillata Royle

Abundant in ponds. May, 1969. 3285.

Ottelia alismoides (L.) Pers.

Occasional but gregarious in roadside ponds. Flowers white. Fls. October, 1969. 3447.

Vallisneria spiralis Linn.

Abundant in ponds. Fls. May, 1969. 3276.

Orchidaceae

Eulophia epidendracea (Retz.) Fischer

Rare. Flowers greenish-white with purplish streak. Fls. December, 1970. 3887.

Habenaria hollandiana Sant.

Rare in cool, shady and moist places. Flowers dull white, with greenish tinge. Fls. December, 1969. 3606A.

H. digitata Lindl.

Occasional. Flowers dull white. Fls. December, 1969, 1970. 3606D, 3966.

H. plantaginea Lindl.

Occasional. Flowers pure white. Fls. December, 1969. 3606.

H. platyphylla Spr.

Occasional. Flowers white. Fls. January, 1970. 3806.

Vanda roxburghii R. Br.

Rare. Frts. December, 1970. 4153.

Hypoxidaceae

Curculigo orchioides Gaertn.

Common in the undergrowth in forests. Flowers yellow. Fls. November-December, 1969, 1970. 3482, 3577, 3797.

Dioscoreaceae

Dioscorea oppositifolia Linn.

Common. Flowers greenish. Fls. December, 1970. 3891, 4173.

D. pentaphylla L. var. **linnaei** Pr. & Burk.

Common. Flowers small green. Fls. November-December, 1969, 1970. 3460, 3609, 3957.

Liliaceae

Aloe barbadens Mill.

Occasional in scrub jungles. Flowers saffron red. Fls. November, 1970. 3801.

Asparagus racemosus Willd.

Common in forests. Frts. December, 1969, 1970. 3639, 3958.

Gloriosa superba Linn.

Common. Flowers red with yellow streaks. Fls. November-December, 1969, 1970. 3524, 3626, 3937.

Iphiginea indica (L.) A. Gray
Rare among grasses. Flowers deep purple. Fls. and Frts. November, 1969. 3512.

Scilla hyacinthiana (Roth.) Macbr.
Common during monsoon in grass lands. Flowers mauve. Fls. and Frts. October, 1971. 4101, 4125.

Haemodoraceae

Sansevieria roxburghiana Schult.
Common in dry places in scrub jungles. Flowers white. Fls. January, 1971. 3954, 4150.

Commelinaceae

Amischocephalus axillaris (L.) Rao & Kamathy
Common among grasses. Flowers purple. Fls. and Frts. December, 1970. 3826.

Commelina benghalensis Linn.
Common in moist places. Flowers blue. Fls. and Frts. October-November, 1969. 3565.

C. diffusa Burm. f.
Common trailing on the ground. Flowers purple. Fls. and Frts. October, 1971. 4103.

C. fasciculata (Heyne ex Roth) Schult.
Common among grasses. Flowers blue. Fls. October, 1970. 4102.

C. tuberosa (Roxb.) Schult.
Common in the undergrowth. Flowers blue. Fls. November, 1969. 3501.

Murdania spirata (L.) Bruckn.
Common. Flowers purple. Fls. and Frts. December, 1970. 3861.

Palmaceae

Borassus flabelliformis Linn.
Common all over the district in the plains. Frts. May-June, 1969. 3565.

Phoenix humilis Royle var. **pedunculata** Becc.
Rare in the forests. In the absence of reproductive organs identification is provisional. December, 1970. 3939.

P. sylvestris (L.) Roxb.
Common in the plains. Frts. May, 1969. 3247, 3800.

Araceae

Arisaema leschenaultii Bl.
Rare in the Visvodaya College building construction site. The specimens match with the herbarium sheets at Madras Herbarium. In the absence of flowers and fruits identification is provisional. November, 1970. 3854.

Aponogetonaceae

Aponogeton natans (L.) Engl. & Krause
Common in temporary ponds. Flowers mauve. Fls. November, 1969. 3509.

Najadaceae

Najas minor All. var. **spinosa** Rendle
Abundant in a pond at Kasigardens. Frts. May, 1969. 3286.

Eriocaulaceae

Eriocaulon quinquangulare Linn.
Common and abundant on moist margins of roadside puddles. Heads grey-white. Heads. December, 1970. 3844.

Cyperaceae

Bulbostylis barbata (Rottb.) Cl.
Common. Spikelets November, 1969. 3475.

Cyperus aristatus Rottb.
Common along roadside temporary ponds. Spikelets December, 1970. 3840.

C. clarkei T. Cooke.
Occasional. Spikelets November, 1969. 3494.

C. compressus Linn.
Common. Spikelets February, 1971. 4100.

C. iria Linn.
Common in rice fields. Spikelets November, 1969, 1970. 3533, 4137.

C. polystachyos var. **laxiflorus** Bth.
Common. Spikelets December, 1970. 3990.
C. tenuispica Steud.
Common. Spikelets December, 1970. 3989.
C. triceps (Rottb.) Endl.
Common among grasses. Spikelets in white heads. December, 1970. 3836, 3838.
Eleocharis capitata R. Br.
Common in the crevices of rocks in the river bed. Spikelets, May, 1969. 3253.
Fimbristylis argentea Vahl
Common. Spikelets June, 1969. 3307.
F. falcata (Vahl) Kunth.
Common in moist places in river bed. Spikelets, November, 1970. 3803.
F. littoralis Gaud.
Common. Spikelets December, 1970. 3835.
F. ovata (Burm. f.) Kern
Occasional. Spikelets November, 1969. 3498.
F. shoenoides Vahl
Occasional. Spikelets December, 1970. 3837.
F. tenera R. & S.
Common. Spikelets November, 1969. 3494.

Gramineae

Apluda mutica Linn.
Common. Spikelets December, 1970. 3975.
Aristida adscencionis Linn.
Common. Spikelets December, 1969. 3288, 3338.
A. depressa Retz.
Common. Spikelets June, 1969, December, 1970. 3337, 3843, 3874.
Centotheca lappacea Desv.
Common. Spikelets December, 1970. 3900.
Chloris barbata Sw.
Common. Spikelets June, 1969. 3358.
Cymbopogon martinni (Roxb.) Wats.
Common on hill slopes. Spikelets December, 1970. 3893.
Eleusine coracana Gaertn.
Cultivated. Spikelets February, 1971. 4021.
Eragrostis aspera Nees
Common. Spikelets December, 1970. 3859.
E. gangetica (Roxb.) Steud.
Occasional. Spikelets December, 1970. 3842.
E. tenella R. & S.
Common. Spikelets May, 1969. 3303.
Heteropogon contortus (L.) P. Beauv. ex R. & S.
Common. Spikelets December, 1970. 3841, 3925, 3987.
Melanocenchris jacquemontii Jaub. & Spach.
Occasional. Spikelets November, 1969. 3491.
Oplismenus compositus Beauv.
Common. Spikelets December, 1970. 3611.
Panicum psilopodium Trin.
Common. Spikelets December, 1970. 3994.
Pennisetum hohenackeri Hochst.
Cultivated as a fodder plant. Spikelets February, 1971. 4003.
Perotis indica (L.) O. Kuntze
Common. Spikelets May, 1969. 3262.
Saccharum spontaneum Linn.
Common and gregarious along water courses. Spikelets February, 1971. 4020.
Sporobolus piliferus Kunth.
Rare. Spikelets November, 1969. 3491.

Acknowledgements

I am grateful to Dr. Cecil J. Saldanha, St. Joseph's College, Bangalore, for helpful suggestions; Dr. G. L. Shah, Reader in Botany, Sardar Patel University, Vallabh Vidyanagar, for identification of grasses and encouragement; Prof. E. Govindarajulu, Presidency College, Madras, for identification of cyperaceous plants; the Director, Botanical Survey of India, Calcutta for his permission to work at the Botanical Survey of India, Coimbatore and to the Vice-Chancellor, S. V. University, Tirupati, for sanction of UGC Travel Grant to visit BSI, Southern Circle, Coimbatore.

LARVAL HISTORY OF THE SPIDER CRAB, *SCHIZOPHRYS ASPERA* (H. MILNE-EDWARDS) (BRACHYURA, MAJIDAE) AS OBSERVED IN THE LABORATORY[1]

V. S. KAKATI[2] AND V. N. NAYAK[3]

(With four text-figures)

The present paper deals with the larval history of the spider crab, *Schizophrys aspera* (H. Milne-Edwards) as observed in the laboratory. The metamorphosis comprises 2 zoeal and a megalopa stage at sea water temperature ranging from 26°C to 27.5°C and salinity about 33 ppt. During the experiment the larvae were fed with freshly hatched *Artemia* nauplii. All larval stages have been figured and described in detail.

INTRODUCTION

Though larvae of many species of spider crabs have been known since Rathke's (1840) first description of the zoeae of *Hyas araneus* (Yang 1968), no work has been done in the genus *Schizophrys* but for the description of the larvae of a species given by Kurata (1969) as of *S. aspera*.

Except for the laboratory reared larvae of 3 species of the family Majidae, no other spider crab has been reared from the Indian waters. The 3 laboratory reared spider crabs being, *Dehaanius limbatus*, (Kakati & Sankolli 1975b), *Acheus lacertosus* (Kakati & Sankolli 1975) and *Doclea hybrida* (Sankolli & Shenoy 1975). Therefore, the larvae of *Schizophrys aspera*, one of the 3 species of the genus from Indo-west Pacific region (Serene 1968) were reared in the laboratory. The other two species of the genus represented in the region are *S. dama* (Herbst) and *S. hilensis* Rathbun.

The present account deals with the 2 zoeae and a megalopa of *S. aspera* and compares the larvae with those of Kurata's larvae of *S. aspera*.

MATERIAL AND METHODS

An ovigerous female of *Schizophrys aspera* was collected from Ankola rocky shore, west coast of India, on 12th December 1973 and the crab was kept alive in a plastic container until the larvae hatched on 14th December 1973. The rearing method adapted for the experiment was same as described by Kakati & Sankolli (1975).

During the course of the experiment the temperature of the sea water ranged from 26 to 27.5°C and salinity about 33 ppt. Freshly hatched *Artemia* nauplii were used as food for the crab larvae. The shortest period for complete larval development was 8 days.

[1] Accepted May 1977.

[2] *Present address*: Central Marine Fisheries Research Institute, Cochin 682 018, India.

[3] Karnataka University Marine Station, Post-graduate Dept. of Marine Biology, Kodibag, Karwar-581 303. *Present address*: Dept. of Zoology, Govt. Arts & Science College, Karwar-581-301.

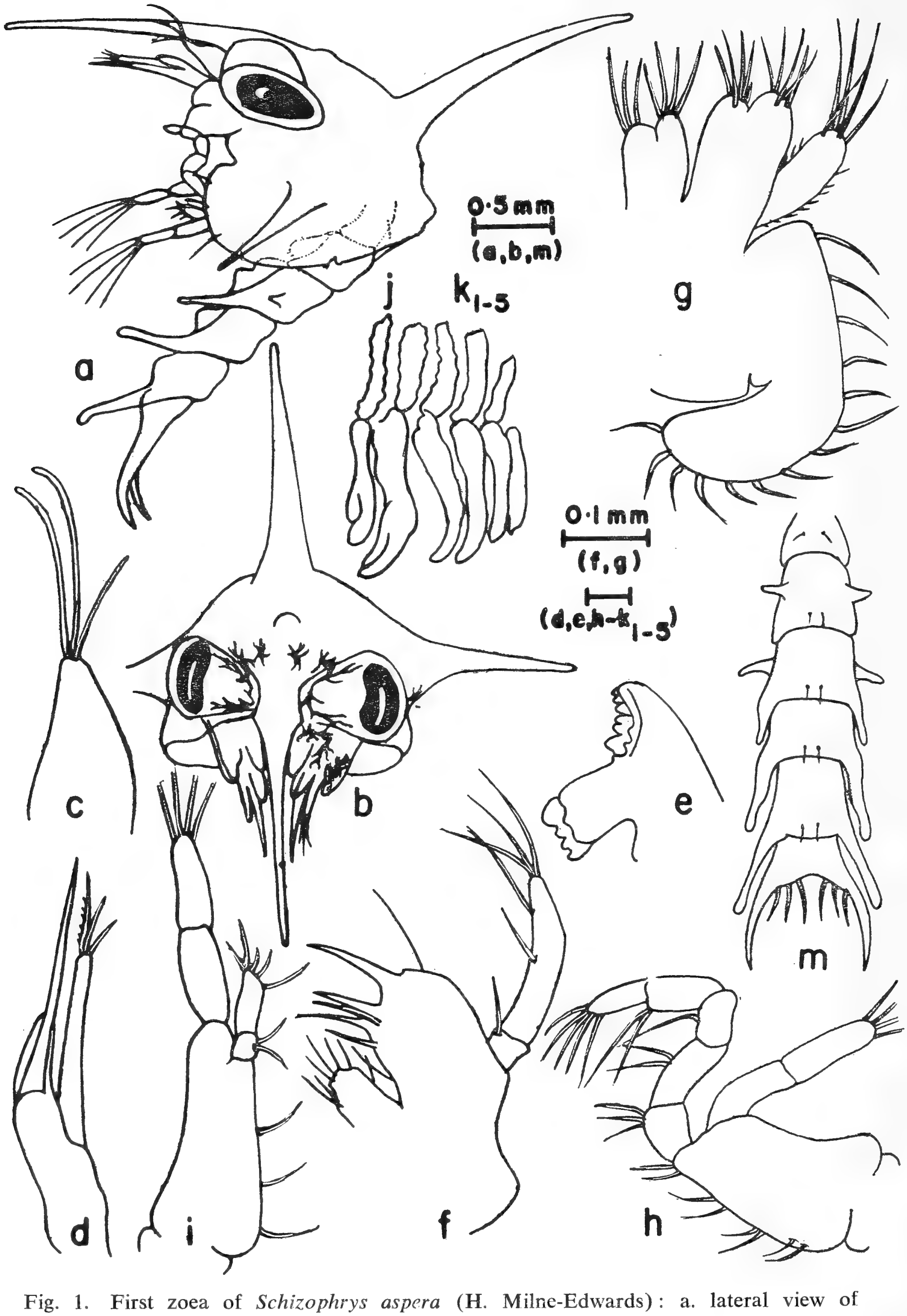


Fig. 1. First zoea of *Schizophrys aspera* (H. Milne-Edwards): a. lateral view of zoea; b. front view of zoea; c. antennule; d. antenna; e. mandible; f. first maxilla; g. second maxilla; h. first maxilliped; i. second maxilliped; j. third maxilliped; k_1-$_5$. pereiopods; m. abdomen.

First Zoea
(Fig. 1)

Rostral spine: 0.90 mm;
Lateral spine: 0.66 mm;
Dorsal spine: 1.03 mm;
Abdomen length: 1.70 mm.
Duration of the stage: 3-4 days.

Carapace smooth, with all three spines; dorsal spine slightly curved backwards; lateral spines more or less straight; the tips of all spines rounded; 3 setae present along the anterolateral border of carapace; prominent mediodorsal and medio-frontal tubercles present.

Antennule (Fig. 1,c): Conical, with 3 unequal aesthetascs. *Antenna* (Fig. 1,d): Spinous process with 2 rows of 10 - 11 spines; exopod with 3 unequal spines which in turn have spinules; endopod bud well developed. *Mandible* (Fig. 1,e): With strongly developed molar and incisor processes and without palp. *First maxilla* (Fig. 1,f): Coxal and basal endites each with 7 setae; palp 2-segmented with a single seta on proximal and 5 setae on distal segments. *Second maxilla* (Fig. 1,g): Both bilobed coxal and basal endites with 3 + 4 and 5 + 5 setae on their lobes; palp unsegmented and with 5 setae terminally, its free margins with minute hairs; scaphognathite with 14 finely plumose setae. *First maxilliped* (Fig. 1,h): Basipod with 8 setae; endopod 5-segmented with 3, 2, 1, 2 and 5 setae arranged distalwards; exopod 2-segmented with 4 natatory setae on its distal segment. *Second maxilliped* (Fig. 1,i): Basipod with 3 setae; endopod 2-segmented with 2 and 5 setae on proximal and distal segments respectively; exopod similar to that of first maxilliped. *Other appendages* (Fig. 1,j & k1-5): Third maxilliped and pereiopods in bud form, the 3rd maxilliped and 1st pereiopod showing biramous and chelate nature respectively; gill buds well developed. *Abdomen* (Fig. 1,m): 5-segmented plus telson, lateral protuberance on 2nd and 3rd segments as illustrated; the postero-lateral sides of segments 3 - 5 produced to form spines with rounded tips, and they increase in length posteriorly; a pair of setae present on all segments. *Telson* (Fig. 1,m): Telson fork wide; cornua smooth; process formula 3 + 3.

Chromatophores: To the naked eye, larvae look reddish brown. Eyestalks reddish-yellow with brownish reticulate chromatophores along their front margins. Carapace spines devoid of chromatophores. All abdominal segments except for telson are crimson red in colour with brownish red branched chromatophores. Basipods of 1st and 2nd maxillipeds reddish in colour with brown reticulate chromatophores. Whole front area is yellowish brown in colour. Other chromatophores are as illustrated and are brownish red in colour. This pattern remains the same for both the zoeal stages.

Second Zoea
(Fig. 2)

Rostral spine: 1.05 mm;
Lateral spine: 0.75 mm;
Dorsal spine: 1.07 mm;
Abdomen length: 2.12 mm.
Duration of the stage: 3 - 4 days.

This stage is characterised by: carapace along its antero-lateral margin carries 5 setae, eyes stalked, mandible with palp bud, maxillipeds with 6 natatory setae, 6th abdominal segment separated from telson.

Antennule (Fig. 2,c): Now with 7 aesthetascs and a seta, with endopod bud near its distal end. *Antenna* (Fig. 2,d): Endopod much elongated extending to about 2/3 of the spinous process. *Mandible* (Fig. 2,e): Now with palp bud. *First maxilla* (Fig. 2,f): Coxal endite with 7 setae and basal with 9; palp 2-

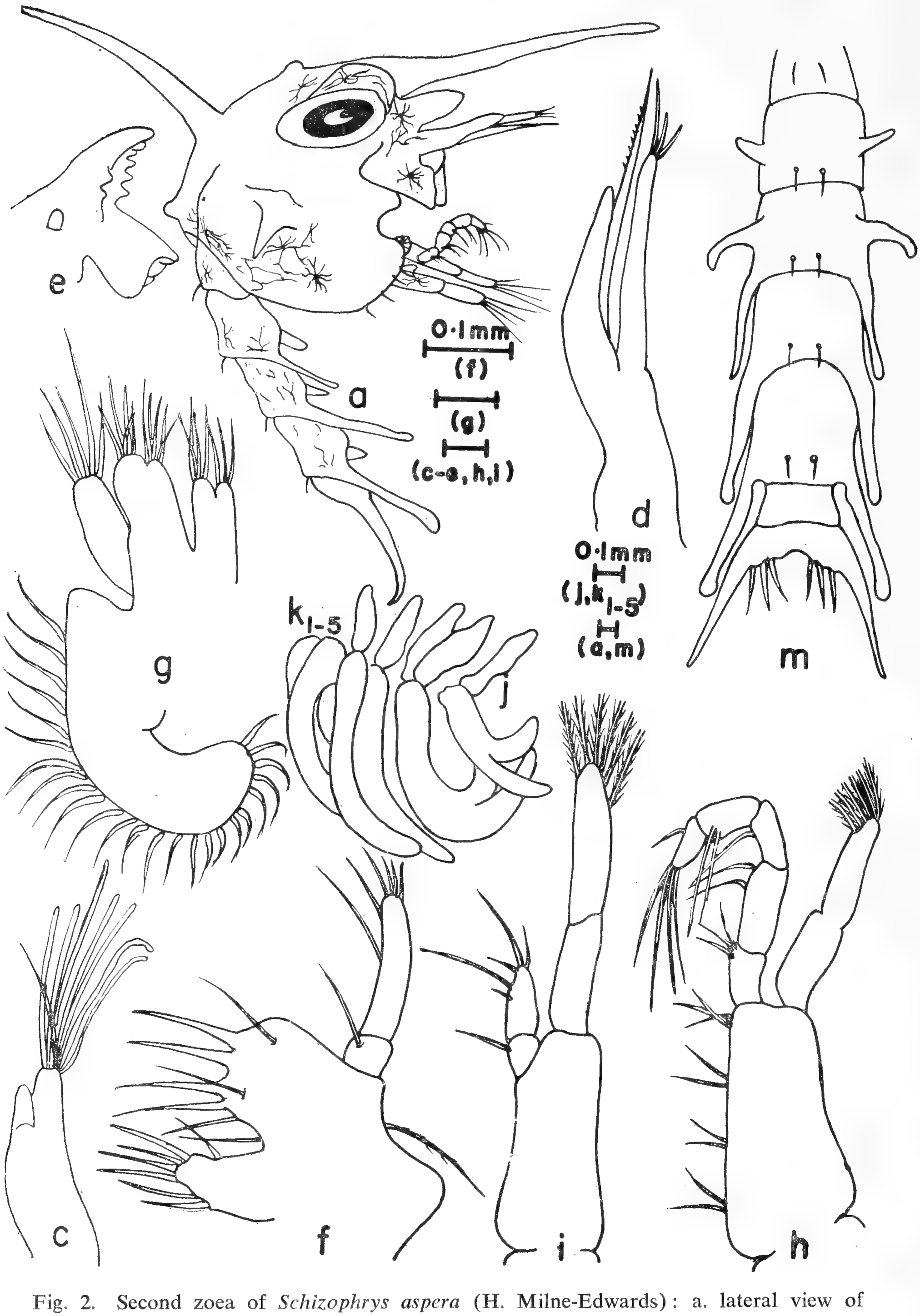


Fig. 2. Second zoea of *Schizophrys aspera* (H. Milne-Edwards): a. lateral view of zoea; c. antennule; d. antenna; e. mandible; f. first maxilla; g. second maxilla; h. first maxilliped; i. second maxilliped; j. third maxilliped; k_{1-5}. pereiopods; m. abdomen.

segmented with 1 and 6 setae on its proximal and distal segments. *Second maxilla* (Fig. 2,g): Both bilobed coxal and basal endites with 3 + 4 and 5 + 5 setae on their lobes; palp with 5 setae; scaphognathite fringed with 25 marginal setae. *First maxilliped* (Fig. 2,h): Except for the increase in number of natatory setae to 6 no other change. *Second maxilliped* (Fig. 2,i): Exopod as in first maxilliped; no other change. *Other appendages* (Fig. 2,j, k1-5): More elongated than in previous stage. *Abdomen* (Fig. 2,m): 6th abdominal segment separated from telson; no other change; *Telson* (Fig. 2,m): No change.

Megalopa
(Figs. 3 & 4)

Carapace length: 1.26 mm; Carapace breadth: 1.03 mm. Duration of the stage: 5 days (none moulting to crab instar).

The carapace is quadrangular, length being slightly more than its breadth, covered with spines and setae, 2 pairs of spines on each side of the gastric region, a central spine in the gastric region; 2 spines in cardiac and a spine in intestinal region, hepatic lobes slightly conical, the rostrum bifid though the centre is conical, a single seta springs at subterminal level of rostral horns, eyes with a pair of setae antero-dorsally.

Antennule (Fig. 3,c): Peduncle 3-segmented, each segment with a single seta, inner flagellum unsegmented and with 2 terminal and 2 subterminal setae, dorsal flagellum 3-segmented, proximal with 1 seta, middle with 6 aesthetascs and distal with 4 aesthetascs basally and a seta terminally. *Antenna* (Fig. 3,d): Peduncle 3-segmented, basal segment with its distal tips forming lobes. The following segments with a seta and 3rd segment with 3 setae, flagellum 4-segmented, proximal 2 segments bare, last two segments distally each with 3 setae. *Mandible* (Fig. 3,e): Masticatory process rounded, palp 3-segmented with 4 stiff setae on the distal segment. *First maxilla* (Fig. 3,f): Coxal endite with 9 setae and basal with 17; palp unsegmented, with 2 short terminal setae. Second maxilla (Fig. 3,g): The lobes of coxal endites each with 4 and basal each with 6 setae; endopod simple without any setae; scaphognathite fringed with 35 - 37 setae. *First maxilliped* (Fig. 3,h): Coxal endite with 8 setae and basal with 12; endopod unsegmented and bare; exopod 2-segmented with 1 and 4 setae terminally on proximal and distal segments respectively; epipod with 5 setobranch-like setae. *Second maxilliped* (Fig. 4,i): Endopod 5-segmented and with 0, 0, 1, 3 and 5 setae arranged distalwards; exopod 2-segmented and with 4 apical plumose setae on the distal segment. *Third maxilliped* (Fig. 4,j): Endopod 5-segmented and setation being, 10, 6, 4, 8 and 4 respectively on proximal to distal segments; exopod 2-segmented and with 4 setae at its tip; epipod with 8 basal setae and 8 setobranch-like setae on its ribbon-like structure, with an arthrobranch. *Pereiopods* (Fig. 4,k1-5): Cheliped on its dorsal side near the base of the palm with a tooth-like structure; setose exopodites of segments 2 - 5 with a tooth on inner side and a protuberance with a seta on outer side, and 4 stiff setae on the inner surface of each of the pereiopods 2-5. *Abdomen* (Figs. 3,a & 4,b): 6-segmented; 2nd and 3rd segments each with a pair of posteriorly directed lateral spines; setation being 2 on 1st and 4 on 2nd to 5th segments and 2 on 6th segment. *Telson* (Fig. 4,n): Rounded and its margin smooth, but on ventral side are 2 setae near uropods. *Pleopods* (Fig. 4,1_1-4,n): Expods of pleopods 1 - 4 each with 10 setae while that of 5th (=uropod) with 5 setae; endopods each with

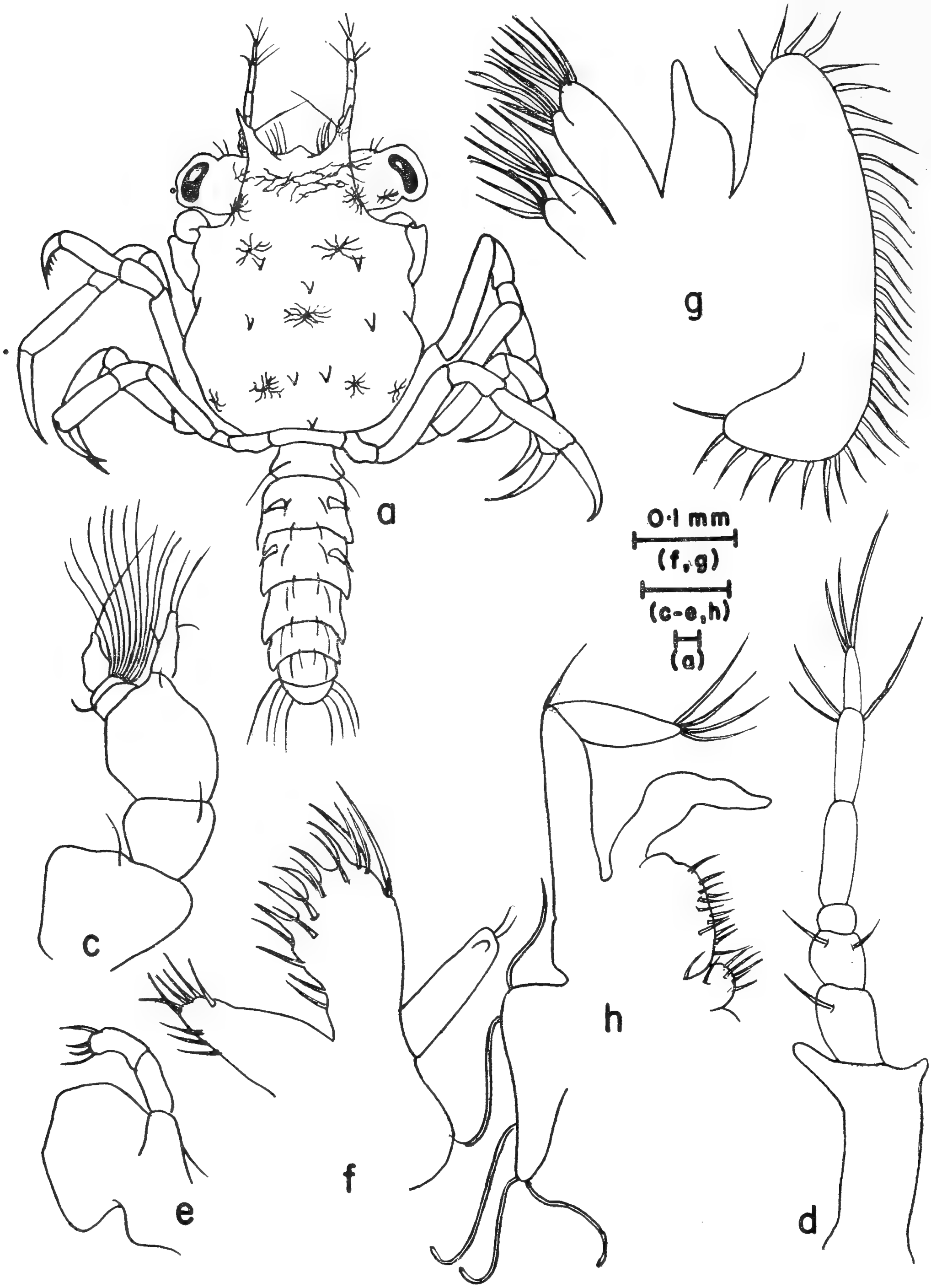


Fig. 3. Megalopa of *Schizophrys aspera* (H. Milne-Edwards): a. dorsal view of megalopa; c. antennule; d. antenna; e. mandible; f. first maxilla; g. second maxilla; h. first maxilliped.

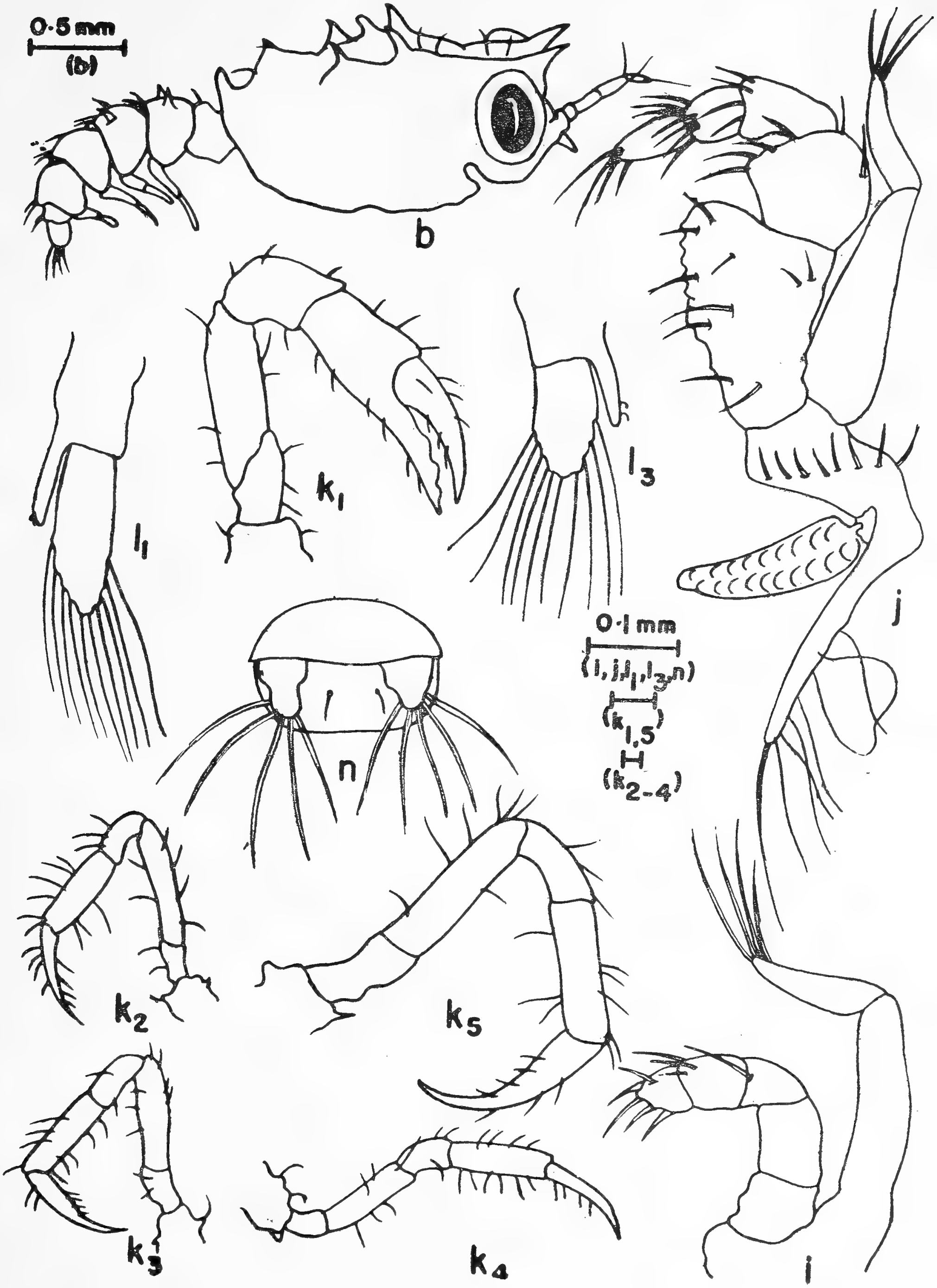


Fig. 4. Megalopa of *Schizophrys aspera* (H. Milne-Ewards): b. lateral view of megalopa; i. second maxilliped; j. third maxilliped; k_1. first pereiopod (cheliped); k_2. second pereiopod; k_3. third pereiopod; k_4. fourth pereiopod; k_5. fifth pereiopod; l_1. first pleopod; l_3. third pleopod; n. telson + uropod.

2 hooks distally.

Chromatophores: General body colour is light yellowish-green; chromatophores are reticulate and are reddish brown in colour. All pereiopod segments and pleopods with reddish brown chromatophores.

Discussion

Like most of the other majid zoeae, the zoea of the present species is far advanced in development at hatching with well developed antennal endopod and pleopod buds.

The zoeae of the present species (Karwar specimen)differ from those of *Schizophrys aspera* described by Kurata (1969) in the following:

The larvae of the Karwar species have the carapace spines with rounded tips; lateral spines being comparatively longer than the other 2 carapace spines; the postero-lateral projection of the abdominal segments 3-5 increase in length posteriorward and with round tips; telson cornua devoid of spines; terminal and proximal segment of endopod of first maxilliped with 4 and 2 setae respectively whereas in the Kurata's larvae, carapace spines are pointed; lateral carapace spines smaller; abdominal projections decrease posteriorward and are pointed; telson cornua each with 3 spines; corresponding maxillipedal segments with 5 and 3 setae.

As far as the megalopa is concerned, in the Karwar specimen, the rostrum has 3 spines, the middle one being broadly triangular, lateral ones each with a seta; epibranchial process of carapace absent; antennal flagellum apically with 3 setae; dorsal spines of 2nd and 3rd abdominal segments directed away from the mid-line whereas in the Kurata's megalopa, median rostral spine prominent; 2 setae each on each of the lateral rostral spines; epibranchial process present; antennal flagellum apically with 2 setae; dorsal spines of abdominal segments 2-3 directed towards the mid-line.

The differences in the morphology of the larvae of Karwar specimen from those described by Kurata (1969) as of *S. aspera* suggest that either Kurata wrongly identified his adult material or that the present material may belong to a hitherto undescribed species. Taxonomy of this species thus needs to be carefully studied in detail, especially in the light of larval evidence, because there is confusion in the identity of *S. aspera* at present and there are many synonyms. Moreover, the revision of the taxonomy of all the 3 species of the genus based on the laboratory reared specimens would be most welcome.

Acknowledgements

We are highly indebted to Dr. L. B. Holthuis of Leiden and Dr. Takeda of Japan for their critical examination of the parent female and the drawings respectively and confirmation of the identification. Sincere thanks are also extended to Dr. K. N. Sankolli for his kind encouragement and guidance. We take this opportunity to thank the authorities of the Karnatak University for providing laboratory facilities, and the C.S.I.R. for the award of Fellowships.

References

Kakati, V. S. and Sankolli, K. N. (1975): Laboratory culture of the spider crab, *Acheus lacertosus* Stimpson (Brachyura, Majidae). *Indian J. Mar. Sci., 4* (2): 185-188.

*——— (1975a): New record of the spider crab, *Dehaanius limbatus* (A. Milne-Edwards) from India. *Indian J. Mar. Sci., 4* (2): 205-206.

——— (1975b): On the metamorphosis

of the spider crab, *Dehaanius limbatus* (A. Milne-Edwards) in laboratory (Brachyura, Majidae). *J. Karnatak Univ. Sci., 20*: 275-282.

KURATA, H. (1969): Larvae of Decapoda Brachyura of Arasaki Sagami Bay IV. Majidae. *Bull. Tokai Reg. Fish. Res. Lab., 57*: 81-127.

SANKOLLI, K. N. AND SHENOY, S. (1975): On a new record of a Majid crab, *Doclea hybrida* (Fabr.) (?) from the Maharashtra waters and its life history. *J. mar. biol. Ass. India, 17* (1): 126-137.

SERENE, R. (1968): The Brachyura of the Indo-west Pacific region in: Prodromous for a check list of the non-planktonic marine fauna of South East Asia. *Singapore National Academy Special Publ. 1*: 33-112.

YANG, W. T. (1968): The zoeae, magalopa, and first crab of *Epialtus dilatatus* (Brachyura, Majidae) reared in the laboratory. *Crustaceana,* Suppl. *2*: 181-202.

* Kakati and Sankolli 1975a, unfortunately have overlooked the paper published by B. F. Chhapgar in the Journal of the Bombay Natural History Society, volume 58, no. 2, of August 1961, on pages 529-531. Chhapgar recorded the spider, crab *Acanthonyx limbatus* A. Milne-Edwards [—*Dehaanius limbatus* (A. Milne—Edwards)] from Port Okha in the above cited reference. Therefore, the priority of recording, *Dehaanius limbatus* (A Milne-Edwards) goes to Chhapgar.

RECORDS OF NYCTERIBIIDAE AND STREBLIDAE (DIPTERA, PUPIPARA) IN KARNATAKA, INDIA[1]

H. R. BHAT, M. A. SREENIVASAN AND
M. A. ILKAL[2]

During a survey of bats and their ectoparasites in the western part of Karnataka in connection with Kyasanur Forest disease epidemiological studies, 1921 specimens of Nycteribiid and Streblid flies were collected. These specimens represent 10 genera and 24 species. They are recorded here with notes on geographic range and host relationship.

INTRODUCTION

The available information on Indian Nycteribiids and Streblids is scattered and scanty, except for a small monograph on ectoparasites of bats from India by Hiregaudar and Bal (1956), which includes 16 species belonging to these two families, occurring in southern India.

The present communication deals with material collected during a survey of bats and their ectoparasites in connection with the serological studies on Kyasanur Forest disease. In all 1921 specimens (947 males and 974 females) were collected. They represent 10 genera and 24 species and are recorded with additional notes on geographic range and host relationships. Perhaps this is the largest collection of Nycteribiids and Streblids ever made in India.

The classification and nomenclature here are based on the system of Maa (1962, 1965, 1966, 1968 and 1969) and Theodor (1955, 1967, 1968a and 1968b).

The area covered during the survey includes Belgaum, Bijapur, Chitradurga, Coorg, Dharwar, Hassan, Shimoga, South Kanara and North Kanara districts of Karnataka State.

MATERIAL AND METHODS

The bats were collected by trapping them in mist nets or in sweep nets from their day-time roost or foraging areas. Whenever it was necessary they were also collected by shooting. They were killed with chloroform vapour, wrapped in white lint cloth and held for four to six hours to allow any live ectoparasites to detach. All the detached ectoparasites were collected and preserved in 70 per cent alcohol after identification.

RESULTS—RECORDS AND NOTES ON SPECIES

Family NYCTERIBIIDAE Westwood, 1840
Sufamily Nycteribiinae Westwood, 1840
Genus *Nycteribia* Latreille, 1796
Subgenus *Nycteribia* Latreille, 1796

1. **Nycteribia (Nycteribia) allotopa** Speiser, 1901

Material examined: 54 ♂♂, 42 ♀♀, all from *Miniopterus schreibersi*.

BELGAUM: 15 ♂♂, 9 ♀♀, removed from bats; 3 ♂♂, 3 ♀♀, from roost; Thigadi, respectively on 18.vi.71 and 5.viii.71. SHIMOGA: 2 ♂♂, 2 ♀♀, Kotipura, 22.viii.71. 14 ♂♂, 15 ♀♀; 20 ♂♂, 13 ♀♀; Kavaledurga, respectively on 18.ii.72 and 3.iv.72.

[1] Accepted July 1977.

[2] Virus Research Centre, Indian Council of Medical Research, Poona, India.

Notes: Originally described from 1 ♂ and 1 ♀, ex *M. schreibersi* collected at Lian Si Pache, W. Sumatra, subsequently recorded from India, Ceylon, Burma, Taiwan, Kiangsu, Moluccas, Philippines, China and Japan from the same host.

The colonies of *M. schreibersi* were also inhabited by other species of bats, but the parasite was not found on them.

2. **Nycteribia (Nycteribia) parvula** Speiser, 1901

Material examined: 73 ♂♂, 64 ♀♀, ex *M. schreibersi*, 1 ♂, ex *Rhinolophus lepidus*.

BELGAUM: 12 ♂♂, 13 ♀♀; 13 ♂♂, 6 ♀♀; Thigadi, respectively on 18.vi.71 and 5.viii.71. SHIMOGA: 29 ♂♂, 25 ♀♀, Kotipura, 22.vii.71. 13 ♂♂, 12 ♀♀; 6 ♂♂, 8 ♀♀; Kavaledurga, respectively on 18.ii.72 and 3.iv.72. 1 ♂, ex *R. lepidus*, Kavaledurga, 3.iv.72.

Notes: Originally described from 2 ♀♀ collected at Lian Si Pache, Sumatra, ex *M. schreibersi*. It has a common distribution range and host specificity with *N. allotopa*. Occurrence on *R. lepidus* is obviously as straggler, as it was cohabiting with *M. schreibersi*.

Genus *Stylidia* Westwood, 1840

3. **Stylidia ceylonica** Theodor, 1967

Material examined: 5 ♂♂, 5 ♀♀, ex *Hipposideros lankadiva*; 1 ♀, ex *Hipposideros speoris*.

NORTH KANARA: 2 ♂♂, ex *H. lankadiva*; 1 ♀, ex *H. speoris*, Gersoppa, 2.xi.71. 1 ♂, 4 ♀♀, ex *H. lankadiva*, Muroor, 31.v.71; 1 ♀, ex *H. lankadiva*, Nislneer, 22.iv.73. SOUTH KANARA: 2 ♂♂, 2 ♀♀, ex *H. lankadiva*, Kamalashile, 10.iv.73.

Notes: So far known only from Sri Lanka ex *H. lankadiva*. Occurrence on *H. speoris* appears to be a straggler as it was cohabiting with *H. lankadiva*.

4. **Stylidia phillipsi** (Scott, 1925)

Material examined: 40 ♂♂, 52 ♀♀, ex *Rhinolophus rouxi*; 1 ♂, ex *Hipposideros bicolor*.

SHIMOGA: 4 ♂♂, 7 ♀♀; 1 ♂, 4 ♀♀; Haravadike, respectively on 20.iii.68 and 18.vi.68. 1 ♂, 4 ♀♀, Nellikoppa, 20.iii.68. 3 ♂♂, 3 ♀♀, Thoragodu, 11.v.68. 3 ♂♂; 6 ♂♂, 4 ♀♀; 1 ♂, 3 ♀♀; 6 ♂♂, 2 ♀♀; 3 ♂♂, 3 ♀♀; Kasaraguppe, respectively on 23rd and 31.v.68, 13, 22 and 26.vi.68. 3 ♂♂, 7 ♀♀, Hale Ikkeri, 3.v.71. 4 ♂♂, 3 ♀♀, Gilalgundi, 14.vii.71. 1 ♀, Byrekoppa, 25.xi.71.

COORG: 3 ♀♀, Gadduge gate, 31.vii.71. N. KANARA: 1 ♀, Kagaal, 5.xi.71. 5 ♂♂, 7 ♀♀, Muroor, 29.iii.72. 1 ♂, ex *H. bicolor*, Muroor, 31.v.72.

Notes: The species has been recorded earlier from Ceylon and India ex *R. rouxi*. The record ex *H. bicolor* appears to be of a straggler, because the species was associated with *R. rouxi*.

5. **Stylidia** sp. 1

Material examined: 1 ♂, ex *R. lepidus*.

NORTH KANARA: 1 ♂, Muroor, 29.iii.72.

Notes: The species resembles *S. szechuana* (Theodor, 1954) closely.

6. **Stylidia** sp. 2

Material examined: 3 ♂♂, 17 ♀♀, ex *R. lepidus*, Kavaledurga, SHIMOGA, 3.iv.72. 2 ♀♀, ex *R. lepidus*, Kamalashile, SOUTH KANARA, 10.iv.73.

Genus *Basilia* Miranda Ribeiro, 1903

Subgenus *Basilia* Miranda Ribeiro, 1903

7. **Basilia (Basilia) majuscula** (Edwards, 1919)

Material examined: 24 ♂♂, 41 ♀♀, ex *Pipistrellus ceylonicus*.

BELGAUM: 1 ♀, Thigadi, 5.viii.71. BIJAPUR: 1 ♂, 1 ♀, Badami, 15.ix.71. CHITRADURGA: 1 ♂, 7 ♀♀, Chitradurga, 24.vi.71. DHARWAR: 3 ♂♂, 1 ♀, Kaginelli, 16.vii.71; 6 ♂♂, 6 ♀♀, Uppinbetegeri, 4.viii.71; 2 ♀♀, Amminbhavi, 4.viii.71; 1 ♂, 1 ♀, Nargund, 13.ix.71. HASSAN: 1 ♂, 4 ♀♀, Banavara, 28.vii.71. SHIMOGA: 4 ♂♂, 1 ♀, Ikkeri, 9.vii.71; 7 ♂♂, 17 ♀♀, Sagar, 11.v.72.

Notes: Earlier recorded from India, Java, Sumatra and Philippines ex *Pipistrellus* spp. The Indian form was originally described as *B. scotti* Hiregaudar and Bal, 1956 and was later synonimised with *B. majuscula* by Theodor, 1967.

8. **Basilia (Basilia)** sp.

Material examined: 7 ♂♂, 12 ♀♀, ex *Myotis peshwa*, Vakkund, BELGAUM, 19.vi.71.

Notes: The species comes close to *B. nana* Theodor and Moscana, 1954.

Subgenus *Paracyclopodia* Scott, 1917

9. **Basilia (Paracyclopodia) roylii roylii** (Westwood, 1835)

Material examined: 10 ♂♂, 23 ♀♀, ex *Scotophilus temmincki*.

SHIMOGA: 2 ♂♂, 4 ♀♀, Sagar town, 11.v.72. NORTH KANARA: 8 ♂♂, 19 ♀♀, Nagire near Gersoppa, 4.xi.71.

Notes: Recorded from India, Ceylon, Burma and Malaya. Recorded hosts are *Scotophilus* spp., *Hesperotenus tickelli*, *Tylonycteris pachypus*, *Megaderma lyra* and *Pipistrellus coromandra*.

Subgenus *Tripselia* Scott, 1917

10. **Basilia (Tripselia) blainvillii amiculata** (Speiser, 1907)

Material examined: 1 ♂, 1 ♀, ex *Taphozous longimanus*, Ikkeri, SHIMOGA, 30.xii.71.

Notes: Earlier records are from India, Burma, Ceylon, Borneo and Sumatra ex *Taphozous* spp.

Genus *Penicillidia* Kolenati, 1863

Subgenus *Penicillidia* Kolenati, 1863

11. **Penicillidia (Penicillidia) indica** Scott, 1925

Material examined: 29 ♂♂, 23 ♀♀, ex *M. schreibersi*.

BELGAUM: 2 ♂♂, 8 ♀♀, Thigadi, 18.vi.71. SHIMOGA: 2 ♂♂, 2 ♀♀, Kotipura, 22.vii.71. 20 ♂♂, 6 ♀♀; 5 ♂♂, 7 ♀♀; Kavaledurga, respectively on 18.ii.72 and 3.iv.72.

Notes: Earlier records are from India ex *M. schreibersi* and Ceylon ex *M. schreibersi* and *P. ceylonicus*.

12. **Penicillidia** sp.

Material examined: 1 ♂, 1 ♀, ex *R. lepidus*, Muroor, N. KANARA, 29.iii.72.

Subfamily Cyclopodiinae Theodor, 1967

Genus *Eucampsipoda* Kolenati, 1857

13. **Eucampsipoda latisterna** Schuurmans Stekhoven, 1938

Material examined: 169 ♂♂, 126 ♀♀, ex *Rousettus leschenaulti* and 1 ♂, ex *H. lankadiva*.

SHIMOGA: 6 ♂♂, 7 ♀♀; 4 ♂♂, 3 ♀♀; Nadakalasi, respectively on 7.ii.68 and 1.vii.71. 11 ♂♂, 16 ♀♀, Horabail, 17.ii.68. 6 ♂♂, 7 ♀♀, Mungarvalli, 21.ii.68. 1 ♂, 3 ♀♀, Heggodu (Sorab), 9.iii.68. 1 ♂, 2 ♀♀, Patresalu, 22.iii.68. 17 ♂♂, 15 ♀♀, Ikkeri, 16.vi.71. 3 ♂♂, 2 ♀♀, Mundigesara, 10.ix.71. 6 ♂♂, 5 ♀♀; 18 ♂♂, 7 ♀♀; Kangodu, respectively on 10.ix.71 and 15.x.71. 7 ♂♂, 6 ♀♀; 12 ♂♂, 7 ♀♀; Harogoppa, respectively on 27.x.71 and 18.xi.71. 4 ♂♂, 3 ♀♀, Bileyur, 19.xi.71. 9 ♂♂, 5 ♀♀, Bandagadde, 17.xi.71. BELGAUM: 3 ♂♂, 3 ♀♀, Thigadi, 21.vi.71. NORTH KANARA: 34 ♂♂, 23 ♀♀, Kagaal, 8.xi.71, 12 ♂♂, 8 ♀♀; 15 ♂♂, 4 ♀♀; Muroor, respectively on 7.iv.72 and 31.v.72. 1 ♂, ex *H. lankadiva*, Muroor, 31.v.72.

Notes: Originally recorded under *Eucampsipoda hyrtlii* ex *R. leschenaulti* from Orissa, Assam and Bombay in India; ex *R. seminudus* and *Tylonycteris pachypus* from Sri Lanka and from a cave in Thailand. The record from *H. lankadiva* is apparently of a straggler.

14. **Eucampsipoda sundaica** Theodor, 1955

Material examined: 59 ♂♂, 37 ♀♀, ex *Eonycteris spelaea* and 1 ♂, 1 ♀, ex habitat of the same species in association with *R. leschenaulti;* 1 ♀, ex *H. speoris* from the same habitat.

NORTH KANARA: 24 ♂♂, 15 ♀♀; 17 ♂♂, 13 ♀♀; 12 ♂♂, 6 ♀♀; Nislneer respectively on 8.xi. and 10.xii.72 and 10.i.73. 1 ♂, 1 ♀, from habitat on 8.xi.72. 6 ♂♂, 3 ♀♀; Muroor, 1.i.73. 1 ♀, ex *H. speoris*, Nislneer, 30.xi.73.

Notes: The species has been recorded ex *C. sphinx* from Madras, ex *Pteropus* from Burma, in a cave from Thailand, ex *E. spelaea* from Malaya and Sumatra ex *Rousettus amplexicaudatus* and *E. spelaea glandifera* from Philippines, Mindanao and Palwan (Theodor 1955 and 1967; Maa 1962). Recently the species was also recorded ex *E. spelaea* from Kumaon hills in the western Himalayas (Bhat and Kulkarni 1974).

Genus *Cyclopodia* Kolenati, 1863

Subgenus *Cyclopodia* Kolenati, 1863

15. **Cyclopodia (Cyclopodia) sykesii** (Westwood, 1835)

Material examined: 8 ♂♂, 12 ♀♀, ex *Pteropus giganteus*, Kumsi, SHIMOGA, 9.xi.71.

Notes: Recorded from several localities in India, Sri Lanka and Burma ex *Pteropus giganteus*. There is a single record from China. It may be mentioned here that *Cyclopodia kalyania* Chaudhari and Mitra, 1965 is a synonym of *C. sykesii* according to Maa (1968).

Genus *Leptocyclopodia* Theodor, 1959

Subgenus *Leptocyclopodia* Theodor, 1959

16. **Leptocyclopodia (Leptocyclopodia) ferrarii ferrarii** (Rondani, 1878)

Material examined: 16 ♂♂, 7 ♀♀, ex *Cynopterus sphinx*.

SHIMOGA: 2 ♂♂, Nadakalasi, 18.ii.68. 1 ♂, 1 ♀, Lingadahalli (Chipli), 9.ii.68. 2 ♂♂ Horabail, one each on 17.ii.68 and 30.v.68. 1 ♂, 2 ♀♀, Hennegere, 5.iii.68. 1 ♀, Sagar, 1.vii.71. 3 ♂♂, Kangodu, 15.x.71. 3 ♂♂, 2 ♀♀; 4 ♂♂, 1 ♀; Harogoppa, respectively on 27.x.71 and 18.xi.71.

Notes: Earlier records are ex *C. sphinx* from several localities in India and one record ex *Megaderma lyra;* ex *C. brachyotis* and *C. sphinx* from Ceylon; ex *C. sphinx* from Thailand; ex *C. brachyotis* from Malaya, Sumatra and Borneo; ex *C. horsfieldi* from Java; and also recorded in Vietnam, Cambodia ex undet. hosts.

Family STREBLIDAE Kolenati, 1863

Subfamily Brachytarsinae Maa, 1965

Genus *Megastrebla* Maa, 1971

Subgenus *Megastrebla* Maa, 1971

17. **Megastrebla (Megastrebla) parvior parvior** Maa, 1962

Material examined: 17 ♂♂, 17 ♀♀, ex *R. leschenaulti;* 24 ♂♂, 16 ♀♀, ex *E. spelaea;* and 1 ♀, ex *H. speoris*.

NORTH KANARA: 2 ♂♂, 1 ♀; 1 ♂, 7 ♀♀; 12 ♀♀, 8 ♀♀; ex *R. leschenaulti*, Muroor, respectively on 8.xi.71, 31.v.72 and 3.vi.72. 24 ♂♂, 16 ♀♀, ex *E. spelaea*, 1 ♀, ex *H. speoris* from common habitat at Nislneer, 30.xi.73. SHIMOGA: 2 ♂♂, ex *R. leschenaulti* Kangodu, 15.x.71. 1 ♀, Harogoppa, 27.x.71.

Notes: The species was originally recorded under the name *Nycteribosca gigantea* (syn: *Brachytarsina gigantea*) (Jobling, 1934) which is apparently restricted to the bat genus *Dobsonia* (Maa, 1962) in New Guinea, New Britain and Solomon Islands. The species is described under the present name *parvior* by Maa (1962) on the basis of material collected in Sumba ex *R. amplexicaudatus* and in Malaya ex *Hipposideros* sp. and Batu caves, probably inhabited by *Eonycteris spelaea*. Recently the species was transferred under the present genus by Maa (1971).

Genus *Brachytarsina* Macquart, 1851

18. **Brachytarsina amboinensis** (Rondani, 1878)

Material examined: 50 ♂♂, 79 ♀♀, ex *M. schreibersi*.

BELGAUM: 7 ♂♂, 6 ♀♀; 4 ♂♂, 5 ♀♀; Thigadi, respectively on 18.vi.71 and 5.viii.71. SHIMOGA: 9 ♂♂, 20 ♀♀; Kotipura, 22.vii.71. 18 ♂♂, 20 ♀♀; 12 ♂♂, 28 ♀♀; Kavaledurga, respectively on 18.ii.72 and 3.iv.72.

Notes: According to the available records the species has a geographic range from India to Ryukyu Island, New Caledonia and New South Wales. It occurs chiefly on *Miniopterus*. Occassionally it has also been recorded from *Eonycteris, Rousettus, Rhinolophus* and *Hipposideros*. The records on these species are apparently of stragglers due to the cohabitation of different bat species in the same habitat.

19. **Brachytarsina cucullata** (Jobling, 1934)

Material examined: 3 ♂♂, 8 ♀♀, ex *Taphozous melanopogon*.

BIJAPUR: 2 ♂♂, 7 ♀♀, Badami, 14.ix.71. HASSAN: 1 ♂, 1 ♀, Halebid, 1.viii.71.

Notes: Originally described upon a male ex *T. melanopogon* from Sri Lanka. It has

been recorded from Mindanao ex *T. melanopogon* and *C. brachyotis,* and from Malaya ex *T. melanopogon.*

20. **Brachytarsina modesta** (Jobling, 1934)

Material examined: 17 ♂♂, 31 ♀♀, ex *R. lepidus;* and 28 ♂♂, 30 ♀♀, ex *R. rouxi.*

NORTH KANARA: ex *R. lepidus,* 3 ♂♂, 5 ♀♀ Muroor, 29.iii.72. Ex *R. rouxi*: 14 ♂♂, 7 ♀♀, Muroor, 29.iii.72. 10 ♂♂, 5 ♀♀, Gokarn, 30.v.72. SHIMOGA: ex *R. lepidus*: 1 ♀, Jog, 5.i.72. 12 ♂♂, 21 ♀♀, Kavaledurga 3.iv.72. Ex *R. rouxi*: 1 ♀, Haravadike, 18.vi.68. 11 ♀♀, Ikkeri, 3.v.71. 4 ♂♂, 6 ♀♀, Gilalagundi, 14.vii.71. SOUTH KANARA: 2 ♂♂, 4 ♀♀, ex *R. lepidus,* Kamalashile, 10.iv.73.

Notes: First described by Jobling ex *R. rouxi* from Sri Lanka and subsequently the species was recorded in India from the same species of bat (Hiregaudar and Bal 1956).

21. **Brachytarsina pygialis** (Jobling, 1934)

Material examined: 19 ♂♂, 40 ♀♀, ex *H. lankadiva* and 2 ♀♀ ex *H. speoris.*

BELGAUM: 1 ♂, 1 ♀, Thigadi, 18.vi.71. CHITRADURGA: 1 ♀, Chandravalli, 25.vi.71. HASSAN: 7 ♀♀, Banavara, 28.vii.71. NORTH KANARA: ex *H. lankadiva*: 3 ♂♂, 5 ♀♀; 2 ♂♂, 1 ♀; Gersoppa, respectively on 15.iii.71 and 2.xi.71. 10 ♂♂, 15 ♀♀, Muroor, 31.v.72. Ex *H. speoris*: 2 ♀♀, Gersoppa, 15.iii.71. SOUTH KANARA: 3 ♂♂, 10 ♀♀, ex *H. lankadiva,* Kamalashile, 10.iv.73.

Notes: Originally described on specimens collected ex *H. lankadiva* from Sri Lanka. From the present record it appears to be associated with *H. lankadiva.* Record from *H. speoris* is apparently of stragglers due to cohabitation of the bats.

Genus *Raymondia* Frauenfeld, 1856

22. **Raymondia joblingi** Hiregaudar and Bal, 1956

Material examined: 45 ♂♂, 56 ♀♀, ex *R. rouxi* and 2 ♂♂, 2 ♀♀, ex *R. lepidus.*

COORG: 3 ♂♂, 3 ♀♀, Gadduge Gate, 31.vii.71. NORTH KANARA: 3 ♀♀, Kagaal, 5.xi.71. 5 ♂♂, 4 ♀♀, Muroor, 29.iii.72. 18 ♂♂, 21 ♀♀, Gokarn, 30.vi72. SHIMOGA: 1 ♀, Haravadike, 20.iii.68. 1 ♀, Thoragodu, 11.v.68. 1 ♂, 1 ♀; 2 ♂♂, 4 ♀♀; 1 ♂; Kasaraguppe, respectively on 31.v, 13.vi, 26.vi. 68. 1 ♂, 10♀♀, Ikkeri, 3.v.71. 13 ♂♂, 6 ♀♀, Gilalagundi, 14.vii.71. 1 ♂, 2 ♀♀, Byrekoppa, 25.xi.71. Ex *R. lepidus*: 2 ♂♂, 1 ♀, Jog falls, 5.i.72. 1 ♀, Kavaledurga, 3.iv.72.

Notes: First described from India ex *R. rouxi* by Hiregaudar and Bal (1956). Appears to be associated with *R. rouxi. R. lepidus* and *R. rouxi* are commonly found in association with each other.

23. **Raymondia molossa** (Giglioli, 1864)

Material examined: 211 ♂♂, 206 ♀♀, ex *Megaderma lyra.*

SHIMOGA: 14 ♂♂, 11 ♀♀, Gilalagundi, 14.vii.71. 6 ♀♀, Bileyur, 19.xi.71. 42 ♂♂, 29 ♀♀, Gavatoor near Ripponpeth, 2.xii.71. 15 ♂♂, 18 ♀♀, Kudroor, 9.xii.71. 35 ♂♂, 35 ♀♀, Kangodu, 1.ii.72. 54 ♂♂, 56 ♀♀, Uddri, 26.v.72. 27 ♂♂, 28 ♀♀, Bandalike, 26.v.72. NORTH KANARA: 24 ♂♂, 23 ♀♀, Banavasi, 17.vi.71.

Notes: The species has been recorded from Sri Lanka and India under the name *R. lobulata* (Speiser, 1900) by Jobling (1930). Consequently the species is designated as *R. molossa* comb. nov. by Maa (1969).

24. **Raymondia pagodarum** Speiser, 1900

Material examined: 26 ♂♂, 19 ♀♀, ex *Hipposideros* spp.

DHARWAR: 4 ♂♂, 4 ♀♀, ex *H. bicolor,* Uppinbetgeri, 4.viii.71. 1 ♂, 2 ♀♀, ex *H. bicolor,* Nargund, 13.ix.71. NORTH KANARA: 1 ♂, 6 ♀♀, ex *H. bicolor,* Gokarn, 30.v.72. 15 ♂♂, 5 ♀♀, ex *H. speoris,* Muroor, 29.iii.72. 5 ♂♂, 2 ♀♀, ex *H. lankadiva,* Muroor, 31.v.72.

Notes: The species has been recorded from *Hipposideros* spp. and *Rhinolophus* spp. from India, Sri Lanka, Burma, Southeast Asia and Pacific Islands.

Discussion

A total number of 24 species of bats have been collected during the survey. Sixteen species of them had one or more species of pupiparan parasites and eight of them did not yield any pupiparan parasite. The details of host

Host-Parasite List

Rousettus leschenaulti	*Eucampsipoda latisterna*
	Megastrebla parvior parvior
Pteropus giganteus	*Cyclopodia sykesii*
Cynopterus sphinx	*Leptocyclopodia ferrarii ferrarii*
Eonycteris spelaea	*Eucampsipoda sundaica*
	Megastrebla parvior parvior
Rhinopoma hardwickei	—
Taphozous longimanus	*Basilia blainvillii amiculata*
Taphozous melanopogon	*Brachytarsina cucullata*
Taphozous theobaldi	—
Taphozous kachhensis	—
Megaderma spasma	—
Megaderma lyra	*Raymondia molossa*
Rhinolophus rouxi	*Stylidia phillipsi*
	Brachytarsina modesta
	Raymondia joblingi
Rhinolophus lepidus	*Nycteribia parvula* (straggler?)
	Stylidia sp. 1 (straggler?)
	Stylidia sp. 2
	Penicillidia sp.
	Brachytarsina modesta
	Raymondia joblingi
Rhinolophus luctus	—
Hipposideros speoris	*Stylidia ceylonica* (straggler?)
	Brachytarsina pygialis
	Raymondia pagodarum
	Eucampsipoda sundaica (straggler?)
	Megastrebla parvior parvior (straggler?)
Hipposideros lankadiva	*Stylidia ceylonica*
	Eucampsipoda latisterna (straggler?)
	Brachytarsina pygialis
	Raymondia pagodarum
Hipposideros bicolor	*Stylidia phillipsi* (straggler?)
	Raymondia pagodarum
Myotis peshwa	*Basilia* sp.
Pipistrellus coromandra	—
Pipistrellus ceylonicus	*Basilia majuscula*
Tylonycteris pachypus	—
Scotophilus temmincki	*Basilia roylii roylii*
Miniopterus schreibersi	*Nycteribia allotopa*
	Nycteribia parvula
	Penicillidia indica
	Brachytarsina amboinensis
Kerivoula picta	—

and parasite associations are presented in the accompanying list. Among the species found negative included a few specimens of *Taphozous theobaldi, Rhinolophus luctus, Pipistrellus coromandra, Tylonycteris pachypus* and *Kerivoula picta;* and more than a dozen specimens of each of the *Rhinopoma hardwickei, Taphozous kachhensis, Megaderma spasma.*

India has a representation of more than a hundred species of bats. Approximately 40 species have been recorded from the present study area. The present sample includes 24 common species. Others are apparently rare or more cryptic in their habit.

A more intensive survey of bat parastites is necessary to have a comprehensive list of Indian bat pupipara.

ACKNOWLEDGEMENTS

We are grateful to Dr. N. P. Gupta, Director, Virus Research Centre, Poona, for constant encouragement and for extending all the facilities, and to the staff of Virus Research Centre, Field Station, Sagar for their assistance during the study.

REFERENCES

BHAT, H. R. AND KULKARNI, S. M. (1974): A survey of haematophagous arthropods in western Himalayas, Sikkim and hill districts of West Bengal—Pupipara. *Indian J. Med. Res. 62* (8): 1121-1133.

HIREGAUDAR, L. S. AND BAL, D. V. (1956): Some ectoparasites of bats from India. *Agra Univ. J. Res.* (*Sci.*) *5* (1): 1-134.

JOBLING, B. (1930): A revision of the genus *Raymondia* Frauenfeld (Diptera, Pupipara, Streblidae). *Parasitology 22*: 283-301.

——— (1934): A revision of the genus *Nycteribosca* Speiser (Diptera, Pupipara, Streblidae). *Parasitology 26*: 64-97.

MAA, T. C. (1962): Records and descriptions of Nycteribiidae and Streblidae (Diptera). *Pacific Ins. 4* (2): 417-436.

——— (1965): An interim world list of batflies (Diptera: Nycteribiidae and Streblidae). *J. Med. Ent. 1* (4): 377-386.

———(1966): Partial revision of the Cyclopodiinae (Diptera: Nycteribiidae). *Pacific Ins. 8* (3): 648-685.

——— (1968): Addition to the Cyclopodiinae (Diptera: Nycteribiidae). *Pacific Ins. 10* (1): 1-23.

——— (1969): The identity and type host of *Strebla molossa* Giglioli (Diptera: Streblidae). *Pacific Ins. 11* (2): 495-496.

——— (1971): Review of the Streblidae (Diptera) parasitic on Megachiropteran bats. *Pacific Ins. Monogr. 28*: 213-243.

THEODOR, O. (1955): On the genus *Eucampsipoda* Kol. and *Dipseliopoda* n.g. (Nycteribiidae, Diptera). *Parasitology 45*: 195-229.

——— (1967): An illustrated catalogue of the Rothschild collection of Nycteribiidae (Diptera) in the British Museum (Natural History), with keys and short descriptions for the identification of subfamilies, genera, species and subspecies. *Brit. Mus.* (*Nat. Hist.*), London. pp. 506, pl. 5.

——— (1968a): Revision of the Streblidae (Diptera) of the Ethiopian region. *Trans R. Ent. Soc. Lond. 120* (16): 313-373.

——— (1968b): New species and new records of Nycteribiidae from the Ethiopian, Oriental and Pacific regions. *Parasitology 58*: 247-276.

A CONTRIBUTION TO THE ORNITHOLOGY OF THE RISHI GANGA VALLEY AND THE NANDA DEVI SANCTUARY

T. M. REED[2]

(*With two text-figures*)

The Nanda Devi Sanctuary, Garhwal Himalaya, Uttar Pradesh was visited by a party from Cambridge University June-August 1977. Observations were made of the birds around Joshimath, on the trek to and from the Sanctuary & within the Sanctuary. Details are given for the vegetation and birds of the area. 93 species were seen; some are new records for the area, some are extensions beyond documented altitudinal ranges.

The Rishi Ganga is a tributary of the Dhauli Ganga, draining the Nanda Devi sanctuary area of the Garhwal Himalaya (Fig. 1). The river, which has cut a gorge several thousand feet in depth, is rarely visited: the only visitors being international climbing expeditions which pass through the gorge to reach their base camps. So far no details have been published on either the fauna or flora of the area, except Lavkumar's observations around Joshimath (Lavkumar 1956).[3] The present paper is an attempt to partially remedy this state of affairs by detailing the birds seen in the Sanctuary, on the walks in and out, and for the short period spent in the town of Joshimath prior to the visit to the Sanctuary.

The Sanctuary (Fig. 2), a high level, mountain girt, basin at 13,000-14,000 feet is reached by a nine day trek starting from Lata village. The trek crosses several small ranges thereby avoiding the very difficult section of the lower Gorge. The path eastwards into the basin passes through a variety of vegetation types.

Above Lata village oak changes quickly into a mixture of deodar and blue pine, the only open areas being clearings fired for grazing. The path from Belta Karak to Lata Karak involves a rapid ascent through lichen draped deodar and pine. From this stage onward undergrowth is typically sparse or absent, shrubs only found where soils are either too shallow or unstable for tree growth. The forest then changes to a dense rhododendron forest by 12,000 feet, which itself gives way to alpine meadows. The meadows are dominated by the colourful annuals of the Rosacae family.

The meadows pass quickly into montane grassland with tufted grasses, lichens and squat evergreen shrubs. The grasslands are grazed as far as Dibrugheta by summer flocks from Lata village. In this high area, with passes at 15,000 feet, there are few birds to be seen except for an occasional Impeyan pheasant *Lophophorus impejanus*, wren *Troglodytes*

[1] Accepted February 1978.

[2] Dept. of Zoology, Edward Grey Institute of Field Ornithology, South Parks Road, Oxford OX1 3PS.

[3] Some more data on the fauna has been procured by Mr. Lavkumar during his WWF-sponsored reconnaisance of the Nanda Devi Sanctuary in May-June 1977.

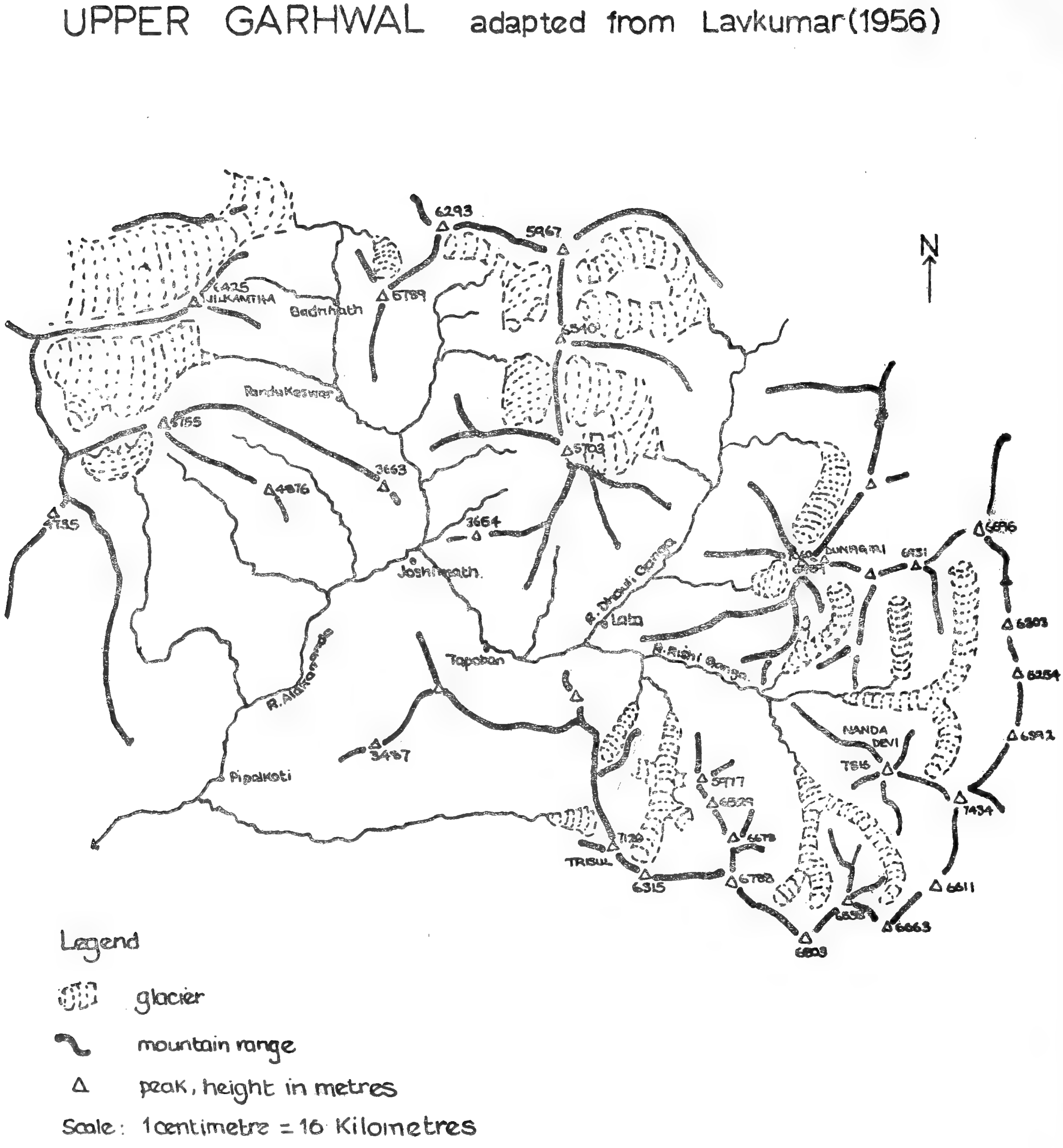


Fig. 1. Nanda Devi sanctuary area of the Garhwal Himalaya.

troglodytes or pipit *Anthus* spp.

A rapid descent from the mountain ridge passes through a zone of alpine flowers, then a belt of scrub and birch *Betula utilis* before returning to the wet forest surrounding the camp of Dibrugheta. The forest here is slightly drier than on the other side of the range, a trend that continues into the Gorge and Sanctuary. This desiccation is progressive, since, as more and more obstacles bar the way that main monsoon winds are quickly drained of much of their load. By the time the monsoon winds reach the Sanctuary the rain is light and in small amount compared to the start of the trek.

From Dibrugheta the path to Deodi climbs back up to the grassland, undulating up and down before finally returning to the coniferous forest. It is noticeable that deciduous trees dominate only the ravines and their immediate surrounds, conifers dominating all other areas below the tree line.

The walk to Ramani is through an admix of rhododendron and birch before returning to pines which dominate beyond the Trisul river, only reverting to birch on the outskirts of the camp area. Beyond Ramani there is little or no tree cover, what there is mainly birch in the base of the gorge, along its tributaries or in inaccessible clefts. The dominant vegetation slowly changes to a sparse cover of montane grasses and squat Ericacae. Only towards the margins of the Sanctuary does scrub juniper *Juniper communis* appear and quickly becomes the dominant cover. By the time the Sanctuary is reached, at the confluence of the Rishi Gangas, the soil is noticeably dry with aromatic herbs present in large numbers for the first time. The two branches of the Rishi Ganga are very similar. In each there is a dominant juniper cover which gives way altitudinally to grasses, prone mosses and lichens, and on riverine soils to annual herbs and dwarf willow *Salix* spp. Both valleys are blocked by glaciers. The woody vegetation extends along the sides beyond the tongue of the glacier before changing slowly to squat alpines and finally to lichens.

The observations listed below were made by members of the Cambridge Garhwal Himalaya expedition in the period early July to late August 1977. Due to pressure of time, and the vagaries of the monsoon, observations on the walks in and out of the Sanctuary were rather brief. By far the largest period of observation was carried out in the Base Camp valley (North Rishi Ganga) and on the slopes of the surrounding peaks.

The valley is surprisingly rich in birds; 43 species being identified, with many of these close to or beyond documented altitudinal limits. The major stronghold is the scrub juniper. In the juniper were warblers *Phylloscopus* spp., Rubythroats *Erithacus pectoralis*, Grosbeaks *Mycerobas* spp., Redstarts *Phoenicurus* spp., and Rose Finches. The other main habitats used by birds were scrub willow and areas of grass and rock debris.

A number of species were observed breeding until the second week of August when there were great numbers of fledglings about. The first movements out of the valley were taking place by the third week of August. During this period several species, previously absent were observed moving down-valley, being first observed high up on the mountain sides and on the glacier margins. Species such as the hoopoe *Upupa epops* and warblers had presumably come over the adjacent divide from Tibet before descending down the Rishi Ganga en route to lowland wintering quarters.

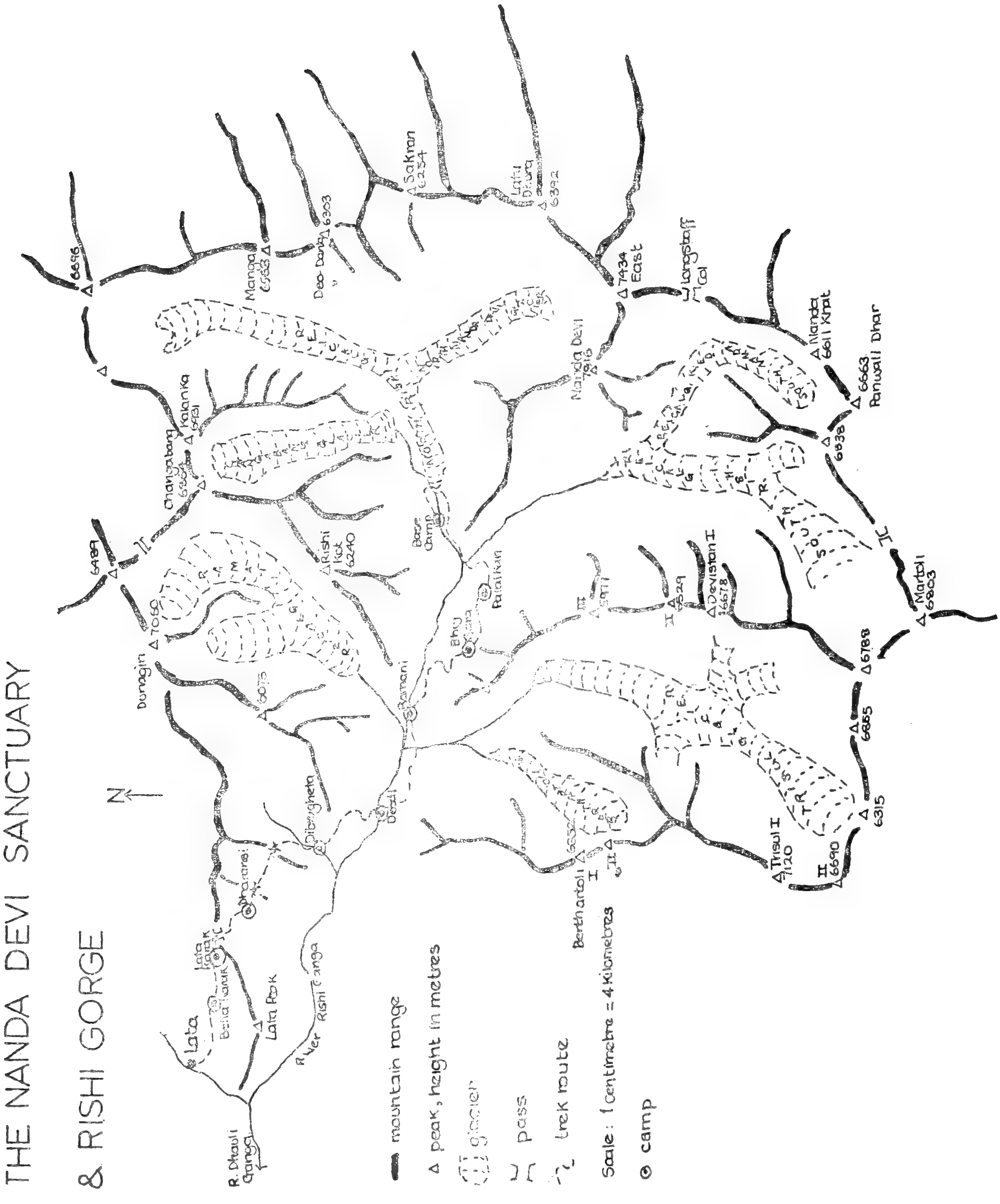


Fig. 2. The Nanda Devi Sanctuary and Rishi Gorge.

List

Anser spp. Geese. A skein seen flying at about 24,000 feet near a col on Nanda Devi.

Milvus migrans Black Kite. Several seen in the vicinity of Joshimath. Very infrequent compared to Lavkumar's notes 1956.

Aquila chrysaetos Golden Eagle. A single adult above Lata village. Two further adults seen in the Sanctuary at Patalkan (15,400 feet). A single bird observed near the Changbang base camp. An adult was mobbed by 150 chough *Pyrrhocorax* spp. on the bluffs above base camp.

Aquila nipalensis Steppe Eagle. A single bird circling just above the forest margins at Joshimath.

Aegypius monachus Black Vulture. A pair circling in the valley between Bhuj Gara and Ramani.

Gyps himalayensis Himalayan Griffon Vulture. Common on thermals above Joshimath. Adults and juveniles seen together below the town. Several on most days above base camp, occasionally mobbed by Redbilled chough *Pyrrhocorax pyrrhocorax*.

Gyps bengalensis Whitebacked Vulture. A single bird above Joshimath.

Neophron percnopterus Egyptian Vulture. Four to five adults and juveniles were commonly seen flying the length of the Joshimath valley.

Gypaetus barbatus Lammergeier or Bearded Vulture. Up to three seen together in the Base camp valley, with one occasion of two adults and a juvenile flying along the bluffline. An adult bird was observed 'bone dropping' for a period of fifteen minutes. The bird carried a pelvic bone aloft, circled, dropped the bone from a height of 300 feet then swung down to collect the bone before repeating the performance. The process was carried out five times before the bone was sufficiently fractured. Before each drop the bird completed an average of two circles to gain sufficient height.

Falco peregrinus Peregrine Falcon. A single bird stooping on a finch in the valley below Lata village.

Falco tinnunculus Kestrel. Up to two in the Base camp valley. On one occasion a single bird mobbed by ten chough. Also seen at Joshimath.

Lerwa lerwa Snow Partridge. A single bird at 15,500 feet in Base Camp valley giving an alarm call.

Tetraogallus tibetanus Tibetan Snow Cock. An adult and four fledglings at 16,500 feet.

Lophophorus impejanus Impeyan pheasant. Three flew from cliffs near Lata Karak, calling vociferously as they descended.

Lophura leucomelana Kalji Pheasant. A pair in the forest near Belta Karak.

Columba leuconota Snow Pigeon. Several pairs in the Base Camp valley. Birds commonly seen in ones or twos. One individual roosted for most of the day on a river cliff.

Columba rupestris Hill Pigeon. Two seen, one of which was crossing a mountain ridge at 17,000 feet.

Columba livia Blue Rock Pigeon. Single birds seen flying in the lower Rishi Gorge. Not noted beyond Deodi. Absent in the Joshimath region.

Collocalia brevirostris Edible-nest Swiftlet. A single bird above the forest at Joshimath.

Upupa epops Hoopoe. A single carrying food at Joshimath. Not noted in the Sanctuary until the end of August, when numbers were seen descending the valley, being noted first high on the mountains above the glacier line. They had probably crossed the mountain range from Tibet.

Picoides macei Fulvousbreasted Pied Woodpecker. Three on a dead tree in mixed forest above Joshimath.

Delichon urbica House martin. Small flocks of up to 20 around cliffs at 15,000 feet on August 1. Three broods on overhanging cliff face at Bhuj Gara being fed on August 26.

Lanius schach Rufousbacked shrike. A single bird on telegraph lines at Joshimath and one between Lata and Joshimath.

Oriolus oriolus Golden Oriole. A single male on a wall at 7,000 feet.

Oriolus traillii Maroon Oriole. In forests near Belta.

Acridotheres tristis Common Myna. Common in Joshimath but few compared to lower altitudes. A single bird mobbed a kestrel at Joshimath.

Pyrrhocorax pyrrhocorax Redbilled Chough & **P. graculus** Yellowbilled Chough. First seen in the Rishi Gorge at Ramani. Found singly or in flocks in the Sanctuary. Flocks built up from the single numbers of the early morning into flocks of up to 150 by late afternoon. 'Play parties' were usually mixed and led by *P. pyrrhocorax*.

Corvus macrorhynchos Jungle Crow. Many in and around Joshimath wheeling in thermals. Also in the fields around Lata.

Corvus corone Carrion Crow. A pair above the alpine meadow flying towards a cliffline at Dibrugheta.

Corvus corax Raven. Single bird around Joshimath and Lata.

Pericrocotus ethologus Longtailed Minivet. Several in a mixed flock of minivets in the forest above Joshimath. Also seen above Lata and near Deodi.

Pericrocotus solaris Yellowthroated Minivet. Several in a mixed flock above Joshimath.

Pericrocotus roseus Rosy Minivet. Several in a mixed flock above Joshimath.

Pycnonotus leucogenys Whitecheeked Bulbul. In open scrub in a clearing in the forest above Joshimath and in scrub between Lata and Joshimath.

Hypsipetes madagascariensis Gray Bulbul. A single bird on telegraph lines in Joshimath.

Heterophasia capistrata Blackcapped Sibia. A single bird followed by a party of Sibias in the forest above Joshimath.

Muscicapa latirostris Brown Flycatcher. A single bird was caught during ringing work in the Base Camp valley.

Muscicapa westermanni Little Pied Flycatcher. A single male in the forest above Joshimath.

Muscicapa thalassina Verditer Flycatcher. A pair on the forest margins at Joshimath.

Rhipidura hypoxantha Yellowbellied Fantail Flycatcher. A pair in pine trees above Dibrugheta camp.

Rhipidura albicollis Whitethroated Fantail Flycatcher. A single bird near Deodi in pine forest.

Phylloscopus affinis Tickell's Leaf Warbler. Present and nesting in good numbers in the Sanctuary in July and August. Nests predominantly in scrub juniper, dwarf spiked shrubs or occasionally in willow. A single bird was caught and ringed. It raised a brood of four from a nest in a bush two feet above the ground. First movements out of the valley began in the second week of August when there were large numbers of juveniles being fed.

Phylloscopus fuligiventer Smoky Leaf Warbler. Two seen in the Base Camp valley in river side scrub.

Phylloscopus trochiloides Greenish warbler. Seen moving down the Sanctuary in mixed warbler flocks in the third week of August.

Abroscopus superciliaris Yellowbellied warbler. A single bird in the forest above Joshimath.

Regulus regulus Goldcrest. In pine and birch forest between Deodi and Ramani at 12,000 feet.

Erithacus pectoralis Himalayan Rubythroat. Two pairs in the Base Camp valley. Immature birds seen being fed in the third week of August.

Erithacus chrysaeus Golden Bush Robin. Seen in scrub at Dibrugheta.

Phoenicurus caeruleocephalus Bluefronted Redstart. Two pairs in the area of burnt juniper scrub near the expedition base camp, with a further pair towards the glacier margins.

Phoenicurus ochruros Black Redstart. Two pairs seen in the Base Camp valley. One nest found in a tributary ravine. Also a pair observed feeding young on the moraine near the snout of Changabang glacier.

Phoenicurus erythrogaster Güldenstädt's Redstart. A male on scree near Changabang moraine.

Chaimarrornis leucocephalus Whitecapped Redstart. Common on all running water above 8,000 feet. Two to three pairs in the Base Camp valley with distinct territorial battles. A nest found 18 feet above the river overhung by grass, and made of dead grass and sedges. Both parents, attended the nest, the male being the more regular of the two.

Rhyacornis fuliginosus Plumbeous Redstart. A male and female on a moraine by the North Rishi Glacier.

Enicurus scouleri Little Forktail. A single bird on boulders in a ravine near Deodi, standing bobbing its tail.

Enicurus maculatus Spotted Forktail. Single birds at Belta, Deodi and Dibrugheta.

Sexicota torquata Stone Chat. Several in scrubby vegetation on the outskirts of Joshimath.

Monticola rufiventris Chestnutbellied Rock Thrush. A pair in oak forest above Joshimath.

Monticola solitarius Blue Rock Thrush. Single birds in a field outside Joshimath and in the Sanctuary at 16,000 feet.

Myiophoneus caeruleus Whistling thrush. On most streams. Commonly seen from Ramani upwards. Song heard from high above the river.

Turdus boulboul Greywinged Blackbird. A pair feeding young in a nest in a rock cleft in scrub on the forest margins above Joshimath.

Turdus merula Blackbird. A single male sitting on a bush near Lata.

Troglodytes troglodytes Wren. Common in scree areas, on cliffs and crags up to 16,000 feet. Much darker than the European form.

Cinclus pallasii Brown Dipper. Seen on the Trisul and North Rishi Ganga rivers. Also noted on a braided section of the Changabang outwash river.

Prunella collaris Alpine Accentor. On bare rocks above the tree line at Dibrugheta. Also a single bird on scree above the base camp.

Prunella strophiata Rufousbreasted Accentor. Two singles seen hopping amongst rocks and herbs on a damp riverside fan in the Base Camp valley.

Prunella atrogularis Blackthroated Accentor. Two in field near Lata.

Prunella immaculata Maroonbacked Accentor. Single birds in fields near Joshimath.

Parus monticolus Greenbacked Tit. Seen in Single bird in fields near Joshimath.

Parus ater Coal Tit. In forest above Joshimath and in a mixed flock at Lata Karak. Also one in pines at 13,000 ft in the Gorge.

Parus rufonuchalis Simla Black Tit. In conifers at Dibrugheta.

Parus modestus Yellowbrowed Tit. In forest above Joshimath.

Tichodroma muraria Wall Creeper. Several seen in the Base Camp valley either on river cliffs or feeding on high turf and scree fields.

Certhia familiaris Northern Tree Creeper. Single birds seen in the oak and pine forest above Joshimath and at 13,000 feet in the Gorge.

Certhia himalayana Himalayan Tree Creeper. A single bird in the forest at 8250 feet.

Anthus hodgsoni Hodgson's Tree Pipit. In low vegetation in the Base Camp valley.

Anthus sylvanus Upland Pipit. Several seen at 13-14,000 feet working over morainic vegetation.

Anthus roseatus Rosebreasted Pipit. Adult observed feeding a fledgling near base camp.

Motacilla alba Pied Wagtail. One or two occasionally seen in the vicinity of the glacier snout.

Passer domesticus House Sparrow. Common around buildings in Joshimath.

Mycerobas affinis Allied Grosbeak. A single male working through low forest cover in the forest above Joshimath.

Mycerobas carnipes Whitewinged Grosbeak. Occasionally seen in the Base Camp valley. A pair observed feeding in juniper scrub at 14,500 feet was joined by a further bird. Single males and females seen foraging at lower heights.

Carduelis spinoides Himalayan Goldfinch. Common in fields and gardens around Joshimath.

Acanthis flavirostris Tibetan Twite. Single birds seen in and around base camp.

Leucosticte nemoricola Hodgson's Mountain Finch. Single birds seen in a ravine in the Base camp valley on two separate occasions, flitting from rock to rock and ledge to ledge, with a further pair in the vicinity of the Changabang Base Camp.

Carpodacus erythrinus Common Rosefinch. Pairs seen frequently in the valley.

Carpodacus nipalensis Nepal Rosefinch. Pair in junipers at 14,000 feet.

Carpodacus rubicilloides Eastern Great Rosefinch. A male and also a pair seen infrequently in the valley.

Carpodacus puniceus Redbreasted Rosefinch. Male observed in juniper and on rhubarb plants.

Propyrrhula subhimachala Juniper Finch. Two pairs seen near base camp with the males frequently observed disputing territory from juniper or willow song posts.

Emberiza cia Rock Bunting. Several pairs in the valley. Secretive but approached close to the camp. Also noted at Deodi and Dibrugheta.

Emberiza fucata Greyheaded Bunting. A male was seen for a ten minute period in fields outside Joshimath and flushed several times. A male was also observed in a bush on a field boundary at Lata.

Melophus lathami Crested Bunting. Several seen at Deodi.

Reference

LAVKUMAR, K. S. (1956): A contribution to the ornithology of Garhwal. *J. Bombay nat. Hist. Soc.* *53* (3) 315-29.

URBANIZATION IN NEST BUILDING OF INDIAN HOUSE CROWS (*CORVUS SPLENDENS* VIEILLOT)[1]

RUDOLF ALTEVOGT[2] AND T. A. DAVIS[3]

(*With sixteen figures*)

Regarding the normal type of nest (-building) in the Indian house crow, one finds the statement by Sálim Ali (1972), that the "nest (consists of) a platform of twigs frequently intermixed with iron wire, with a cup-like depression lined with tow, coir fibre, etc., 10 feet or more up in a tree, sometimes several nests in the same tree...The koel commonly lays its eggs in crows' nests" (p. 91).

In 1927, E. H. Aitken reported that "in April and May crows make nests of sticks and line them with coir, or horsehair abstracted from a mattress, or even with soda-water wire stolen from the butler's little hoard. In these they bring up three or four callow criminals in their own image" (p. 61).

While this statement by EHA refers to the fancy city of Dustipore, probably a rural site in Northern India, the same author relates the crow situation in Bombay as follows: "In Bombay the crow population has multiplied to such an extent of late years that the competition for nesting materials has become terrible. In Marine Lines, as the season advances, the crows patrol the road or the garden walks, waiting for sticks to fall, or they get up into the trees and tug at twigs which are still green and will not come off. It is not many years since a pair living in the Fort discovered a real El Dorado in an optician's shop. They worked at that mine so stealthily and cleverly that before they were discovered they had succeeded in abstracting about Rs. 400 worth of spectacle frames which they had worked up into a very superior nest, combining durability and lightness like a "helical tube". The Museum of the Bombay Natural History Society contains a ponderous nest made entirely of iron wire, taken apparently from the ruins of railway fences" (p. 122, 2. edition). From a statement by Sálim Ali, the editor of the 3-edition in 1947, it can be gathered that this EHA-statement refers to about 1905 (the 2-edition featuring no year of publication). In 1947, Sálim Ali quotes from "The Birds of Bombay and Salsette" (by S. Ali and H. Abdulali) that "crows nesting on the overhead wire carriers of the newly electrified suburban section of the...railway (in 1922) held up the trains by the iron wire used as building material causing short circuit. A new type of insulated bracket had to be devised specially to overcome this unforeseen nuisance".

There are a few further notes on this peculiar habit of wire nesting in Indian crows (Hume, 1889; Dewar, 1929; Baker, 1932; Lamba, 1963), Indian doves (Walsh, 1924), Indian bulbuls (Lamba, 1968), and the latest report by Lamba (1976) states that "dry, usually thorny sticks are picked up from under the trees, hedges around the fields and farms,

[1] Accepted January 1979.

[2] Zoological Institute, Münster University, Badestr. 9, D-4400 Münster, Federal Republic of Germany.

[3] Indian Statistical Institute, 203, B. T. Road, Calcutta 700 035, India.

and from the firewood-piles of poorer people. If fallen sticks are not readily available, twigs are wrenched off the trees. Occasionally metal strips and wires are also brought in for incorporation in the outer framework".

In the non-Indian crows, this wire-nidification seems to be quite an exception: only Walford (1931) and De Vries (1953) report of *Corvus c. corone,* in two nests of which apart from rabbit bones ("a whole set of ribs being fixed in on one side") mainly steel wire had been used. One nest weighed 1845 g (quoted from Melde, 1969). Still, the nest found by Walford "was heavily lined with wool".

Apparently, since these earlier reports the situation in the big cities of India has changed as far as *Corvus splendens* is concerned, and it is for this reason that the following notes, observations and preliminary data are reported here. Moreover, apparently no numerical considerations have been done on the physical properties of crows' wire nests. We plan to extend our studies throughout other regions of India in the near future.

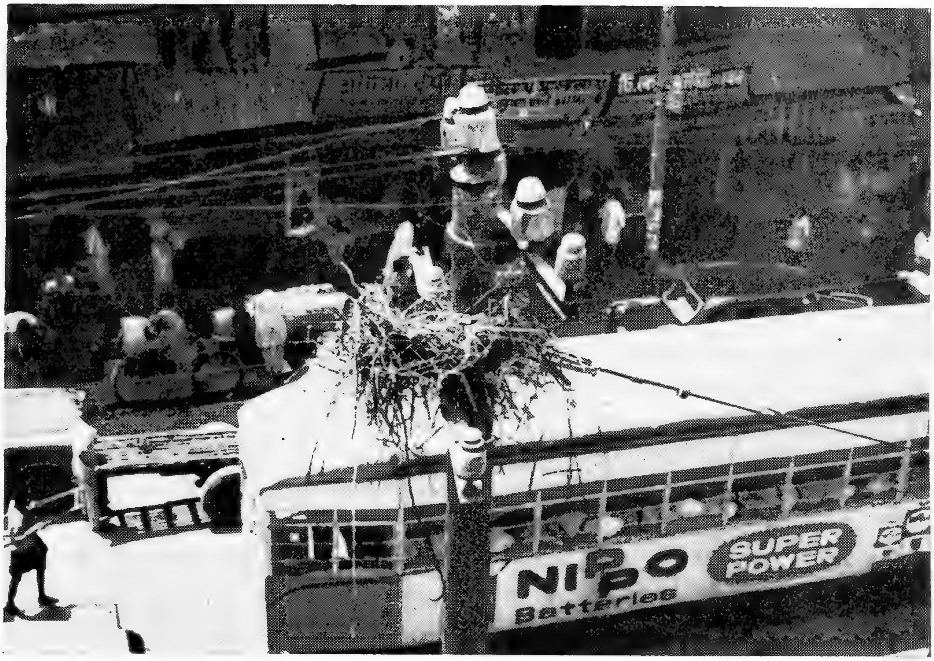
When visiting Calcutta or Bombay, one is struck by the fact that hundreds of nests of *Corvus splendens* are based on electric posts in crowded streets (fig. 1). Most of these nests are built exclusively or partly with metallic wire and pieces of flat sheet. A variety of nesting sites can be noticed, the street lamp probably being the most familiar and most often used. Sign boards on buildings, window sills, between cornices of residential buildings, on the posts supporting power lines of electric trains, on the ceiling of railway station platforms (Howrah!) and waiting halls are some other colonized sites (fig. 2).

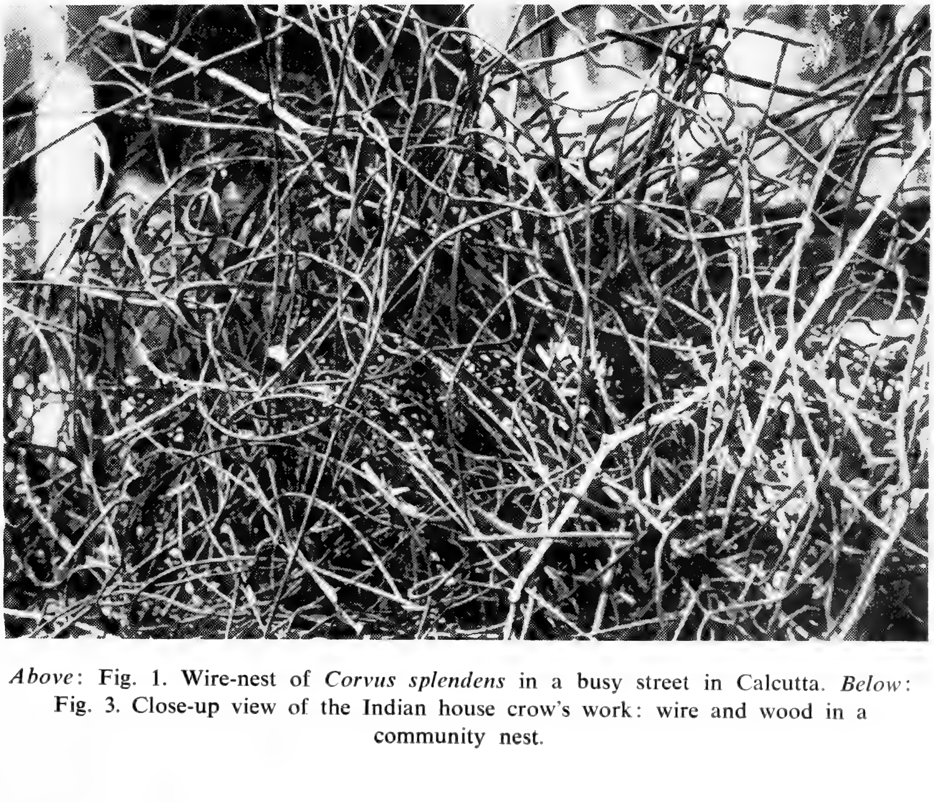
Sometimes many crows compete for one favourable site: on top of a five-storeyed building on the side of a busy road (Barrackpore Trunk Road) an illuminated signboard attracts four to five pairs of crows every year fighting for possession of this site. Ultimately, they compromise, each pair sharing a portion, and they make a sort of a community nest (fig. 3).

In some of the road-crossings in Calcutta, mercury lights on tall posts (fig. 4) have just been introduced. The different hands starting from the terminal of the post slant upwards providing a safe platform for the crow to establish a nest between them. On ordinary lamp posts, nests are built where there are some joints or projections. In such positions, it is not possible to establish twigs, but thin wire, already bent or twisted by the crow itself (fig. 5), is suitable for founding a nest. There is, however, no difficulty to establish a metal nest on trees because of their branching nature: from one large mango tree (*Mangifera indica*) growing in the heart of Calcutta, adjoining the offices of the Reserve Police at Baranagar, twentyfour nests were collected, all built mostly or exclusively with metal (fig. 6).

Normally in rural areas, the house crow builds nests with only dry twigs which may include dry, sharp and branched brambles. The bird also makes a cup inside the nest and lines it with fibre of pliable twigs (fig. 7). Seldom it uses rags and grass blades (see also the above quotations by earlier authors). The nesting season of *Corvus splendens* in the north-eastern parts of India begins in February and extends upto June, after which the heavy monsoon starts.

The use of wire and/or other types of metal depends mostly on the locality and availability of such material. Apparently, however, also a learning process in the sense of handing over the metal habit from crow to crow is concerned. Crows in general do not fetch their





Above: Fig. 1. Wire-nest of *Corvus splendens* in a busy street in Calcutta. *Below*: Fig. 3. Close-up view of the Indian house crow's work: wire and wood in a community nest.

Left: Fig. 2. Detail of wire-nest of *Corvus splendens*.
Right: Fig. 6. Metal nests on a dead tree.

nesting material from long distances (see also Kuhk 1931, Wittenberg 1963, and Melde 1969). While wire seems to be handled effectively though laboriously, other odd-shaped metal objects cannot make a firm and uniform-sized nest. Thicker wires are avoided because they are too heavy to be carried upwards and perhaps because the bird cannot give it the necessary shape. It is surprising, however, that some crows have a fascination for aluminium shirt hangers even though their wires are too thick for the bird to bend. Such hangers were collected by a friend in South Calcutta from a nest founded on the roof of his house (fig. 8).

Some metal nests were pulled down in 1974, but during the 1975 breeding season at most of those sites new nests of approximately the same weight were rebuilt. The following materials were recorded from metal nests:

1) Dry twigs and brambles at varying proportions;

2) Inner cup made of thin shoots and vegetable fibres (fig. 9);

3) Iron wire, often rusted, pliable and of a particular thickness (ranging between 1.5 and 2.0 mm). The preferred wire is usually 25-30 cm long, each weighing not more than 30 grams (fig. 10);

4) Thin strips of metal, perforated flat sheets, grills, expanded metal, springs, coils, discs, cycle pedals, and even aluminium shirt hangers.

Table 1 gives some information on ten nests built entirely with metallic wire. The nests are arranged in descending order of weight. The weight of a nest varied from about 1 kg to more than 6 kg. The number of wires per nest ranged from 91 to 644. There was a proportional range in the total length of wire per nest which was between 43.76 m and 265.32 m. The wires did not vary much in thickness (table 1). These ten nests were collected from a locality covering a distance of one kilometre.

The data on the number, weight and cumulative length of the wire for the ten nests are given in fig. 11. Excepting for a deviation in nests 3 and 4 which had a proportionately greater number of wires than the others, there is a good correlation between the number weight and length of wire in all nests. This again suggests the homogeneity of the nesting

TABLE 1

NESTS OF *Corvus splendens* BUILT COMPLETELY OF WIRE

Nest	Total weight (kg)	Number of wires	Total length of wire (m)	Mean thickness of wire (mm)
1	6.145	644	265.32	1.77
2	4.894	458	218.94	1.81
3	4.466	497	198.14	1.76
4	4.327	569	209.26	1.80
5	2.690	296	116.97	1.75
6	2.689	288	123.69	1.84
7	2.511	275	99.69	1.68
8	1.910	213	85.00	1.83
9	1.618	187	70.29	1.57
10	1.071	91	43.76	1.69

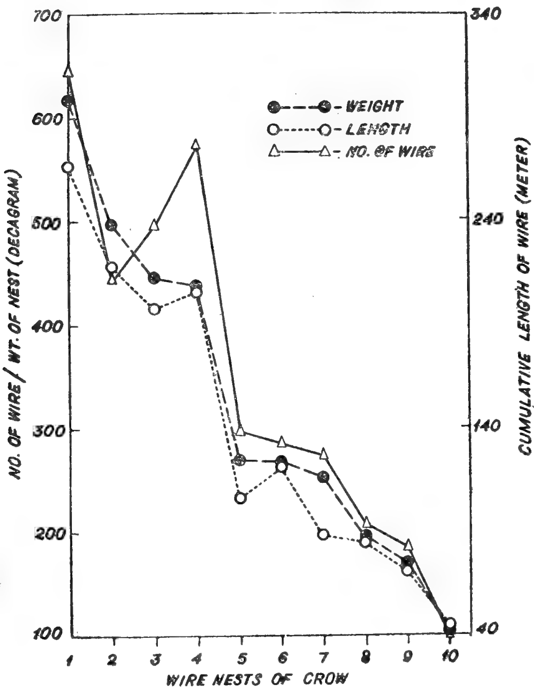


Fig. 11. Number of wires, their weight and cumulative length in 10 pure wire-nests of *Corvus splendens*.

material used. In fig. 12, the frequency distribution of the wire used in nest number 1 from table 1 for their length and weight is shown. While for the majority of the wire the weight is about 10 g, the length ranges from 10 cm to 120 cm with a mode at 30 cm. The longer wires are usually thinner as the bird seems to fix up its limit at 30 g as the weight it can reasonably carry.

Data on four mixed nests gathered from localities about 5 km away from the first one are given in table 2.

These four nests were marked by the presence of twigs and inner fibrous lining. All these nests also had wire. Where more twigs are used, proportionately less metal is supplemented. Flat metals of various size and shape have been used in only two nests. Incidentally, these two nests were pulled down in yet another locality. There are several small workshops in this locality, making small utility articles and toys out of thin metal sheets. Thus, instead of wire, only cut pieces of metallic sheets are available here. Some nests contained a few animal bones, coir rope and clay tea cups.

In another 28 nests of *Corvus splendens* from Calcutta taken in 1975, the following constituents were found (table 3).

In nests 5, 8 and 13, the cup was lined with soft fibre. In nest 7, there was a piece of tyre about 2 cm × 1 cm × 5 cm. Nest 21 had a piece of rope weighing about 10 g.

In some parts of Calcutta and Bombay one

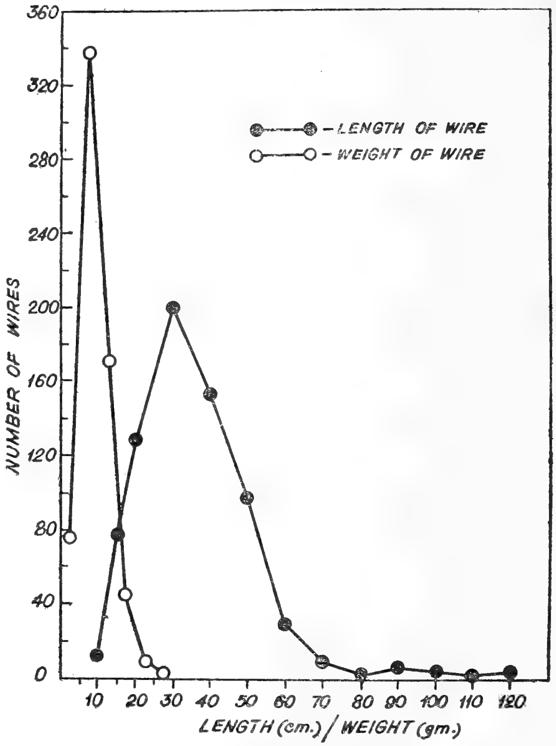


Fig. 12. Frequency distribution of length and weight of wire used by Indian house crows (pure wire-nests).

TABLE 2

NESTS OF *Corvus splendens*: WEIGHT OF CONSTITUENTS OF MIXED NESTS (g)

Nest	Twigs	Inner cup of fibre	Rope	Iron wire	Flat metal small	Flat metal large	Others	Total weight
1	350	185	—	250	—	—	210	995
2	325	190	—	230	—	—	—	745
3	90	—	30	450	385	160	—	1115
4	45	—	65	765	510	675	—	2060

TABLE 3

DETAILS OF NESTING MATERIALS OF *Corvus splendens* FROM CALCUTTA (IN g)

Nest	Total weight	Wire	Flat iron strips	Flat grills	Springs	Wood	Flexible wire
1	8300	8200	80	—	—	20	—
2	7900	7700	150	—	—	50	—
3	5300	4950	200	—	100	50	—
4	5100	4550	350	200	—	—	—
5	4600	3950	—	150	300	200	—
6	4500	4280	—	180	—	20	20
7	4500	3950	—	350	—	150	50
8	3500	3300	—	—	180	20	—
9	3500	3000	500	—	—	—	—
10	3400	3150	—	—	—	250	—
11	3300	3000	250	50	—	—	—
12	3200	2500	500	200	one long umbrella spoke was used		
13	2800	2300	300	—	50	150	—
14	2700	2600	50	—	—	50	—
15	2500	2300	—	200	—	—	—
16	2200	2000	200	—	—	—	—
17	2000	1850	50	100	—	—	10
18	2000	1600	150	—	—	250	—
19	1700	1700	—	one shirt hanger was used in the nest			
20	1600	1350	—	—	—	250	—
21	1500	1430	—	—	50	—	—
22	1300	800	500	—	—	—	—
23	1200	1180	—	—	—	—	20
24	1100	990	10	50	—	—	20
25	1100	930	100	—	—	—	20
26	800	800	—	incomplete nest		—	—
27	800	800	—	incomplete nest		—	—
28	700	700	—	incomplete nest		—	—

finds crows' nests almost completely built of twigs and natural fibres while in others pure metal nests seem to be the rule. This finding suggests population differences in nidification brought about by the gradual spreading of this habit from individual to individual in the sense of a "tradition" (similar to the titmice of London opening the caps of the milk bottles or the habit of food washing in Japanese macaques).

There is also a pseudo-social trait in this expanding habit of metal nidification: due to the super-annual stability and durability of the metal nests, fairly often two nests, quite apart in the first year, tend to be enlarged the following year thus "growing" into the close neighbourhood of each other (fig. 13) until finally they unite, hence forming a community nest. In such nests, sometimes proper brooding is hardly or not all possible (figs. 14, 15), and yet these nests have successful breeding. A striking example of this type of construction is presented by the "sharing nest" from Barrackpore Trunk Road/Calcutta mentioned above. When pulled down in 1974, the entire nest, completely metal, weighed 25 kg. During the 1975 season also, a multi-nest of almost the original size was made, but could not be weighed. It was striking that no lining with organic material for the egg-cup was provided in any part of the community nest. In fact, because of the lack of a regular cup for laying eggs, eggs from two nests were found to lie side by side.

There are some consequences in the context of the metal nidification habit which deserve mentioning:

1) Making a more permanent, super-annual nest of great stability means reduction of labour and saving time (which is obviously used in the urbanized crows for extensive preening and lazying about near the nest). Wooden nests deteriorate within one monsoon season and have to be rebuilt;

2) Protecting the eggs and young from overheating because the wire-nest is more efficiently aerated than the nest made of organic material. No necessity for the parent birds to carry cooling water to the nest (as, for instance in *Vanellus malabaricus* and other birds);

3) Possibly making use of the solar energy for partial incubation of the eggs for which the metal nest is a necessity (and comes in handy due to its preferred site on human constructions like posts, buildings etc., without much shade);

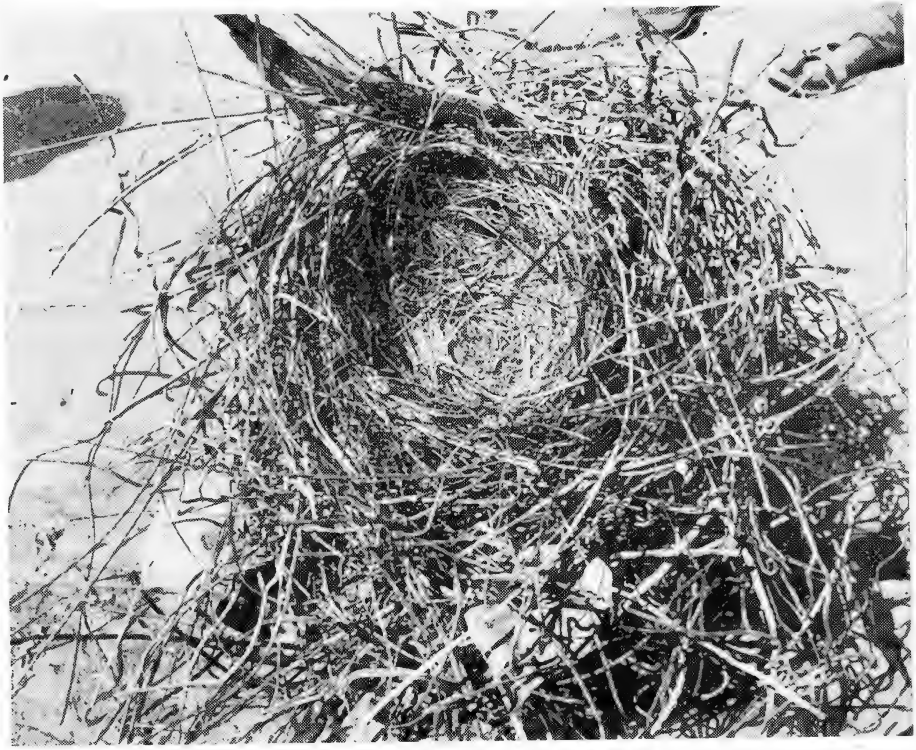
4) Metal nests have the additional advantage of enabling the parents to incubate the eggs during the warm day time, for at such a weather most of the Indian birds avoid brooding over the eggs;

5) Utilizing more advantageous siting niches where the use of wood as nesting material is impracticable;

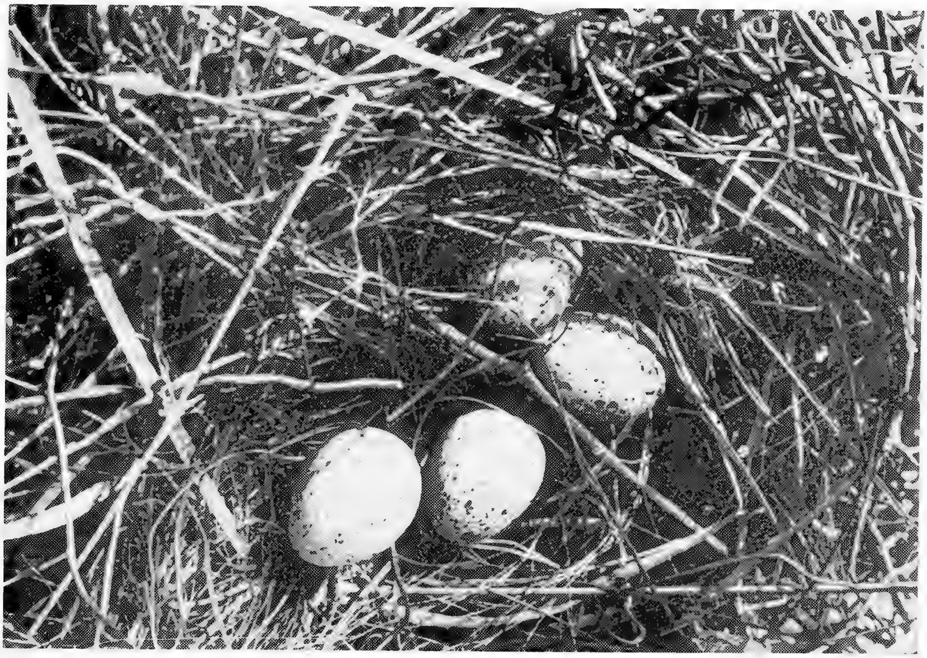
6) Placing the wire-nests on or near lamp posts (fig. 16) means extension of time for scavenging and collecting food even at night. Crows pouncing on not properly packed food and food material carried by lorries and on bus tops are a common sight in Calcutta, even after dark.

There is one possible disadvantage for the crows in that due to the thermal conductivity of metal, the naked nestlings could be affected by the hot wires. Another disadvantage concerns man: Due to the nidification ingenuity of the Indian house crow in urban areas, now and then a power cut is caused especially in the rainy season by the crows' wire-nests short-circuiting the overhead power lines. There is evidence that crows at the suburbs of Calcutta and Bombay are gradually switching

Above: Fig. 8. Wire-nest of Indian house crow featuring an aluminium shirt hanger (Calcutta). *Below*: Fig. 13. Neighbouring wire-nests tend to unite in next year's nidification period.



Above: Fig. 9. Mixed nest: wire construction with inner cup of plant material.
Below: Fig. 10. Pure wire-nest.



Above: Fig. 14. Eggs of three pairs of crows in a community nest (mixed nest). *Below*: Fig. 15. Even in a mixed nest, proper brooding over the eggs is often hardly possible.

over to the new technique of utilizing metal instead of wood in nest building, thus providing an example of urbanization in birds.

Summary

1. In large cities like Calcutta, Dacca and Bombay the Indian house crow (*Corvus splendens*) is increasingly building its nest fully or partially with metallic wire, strips and odds of flat sheets, grills and expanded metal thus relinquishing the ancient habit of building nests entirely of plant twigs and brambles. Compared to the "normal" nest, the metallic construction is stabler and hardly affected by the monsoon climate, hence being utilized again the next year(s). Such nests tend to be enlarged year upon year and confluate to form community nests for several pairs of crows.

2. The advantages of wire nidification are:

a) Utilization of nesting sites where the use of wood as nesting material is impracticable (lamp posts, sign boards, window sills etc.).

b) Super-annual nests mean reduction of labour and saving time which is used for other activities.

c) Protection of eggs and young from overheating by better aeration of the wire-nest: hence no necessity of cooling by the parents.

d) Enabling the parents to incubate the eggs during the warm day time (in "normal" nests most Indian birds do not brood over the eggs during the noon heat).

e) Possibly making use of the solar energy for partial incubation, the preferred nesting site often being unshaded.

f) Placing wire-nests on or near lamp posts means extended time for scavenging even after dark.

3. From 42 nests ranging from pure metal to mixed constructions numerical data were collected. The heaviest metal nest weighed more than 6 kg, the heaviest mixed construction more than 8 kg, while one community nest (metal) housing 5 pairs of crows weighed 25 kg. The number of wires per nest were between 644 and 91 with a cumulative length of 265-91 m per nest, wires of 120-10 cm were taken with a mode of 30 cm being most frequently used. The average thickness of the wire was between 1.5 and 1.8 mm.

Apart from wire, the most conspicuous nest material were two non-pliable aluminium shirt hangers.

4. There is evidence that the wire nesting is spreading in Calcutta, Dacca, and Bombay which is understood as a process of urbanization.

Acknowledgement

We thank Mr. S. K. De, Artist, at the Indian Statistical Institute for preparing the graphs.

References

Aitken, E. H. (1927): The Tribes on my Frontier. Calcutta and Simla.

——————— (1947): The Common Birds of Bombay. 3. ed., Bombay.

Ali, Salim (1972): The Book of Indian Birds. 9. ed., Bombay.

Ali, Salim and Abdulali, H. (1937): The Birds of Bombay and Salsette. J. Bombay nat. Hist. Soc. *39*: 91-103.

Baker, C. S. (1932): Nidification of the Birds of the Indian Empire. London.

Dewar, D. (1929): Indian Birds' Nests. Bombay, Calcutta.

De Vries (1953): Quoted from Melde.

Hume, A. O. (1889): Nests and Eggs of Indian Birds, 2. ed. London.

Kuhk, R. (1931): Brutbiologische Beobachtungen am Nest der Nebelkrähe. *J. Ornithol. 79*: 269-278.

LAMBA, B. S. (1963): The nidification of some common Indian birds—part 1. *J. Bombay nat. Hist. Soc. 60*: 121-133.

——— (1968): Wire nests of redvented bulbul *Pycnonotus cafer* (Linnaeus). *J. Bombay nat. Hist. Soc. 65*: 122.

——— (1976): The Indian crows. A contribution to their breeding biology, with notes on brood parasitism on them by the Indian koel. *Records Zool. Survey India 71*: 183-300.

MELDE, M. (1969): Raben- und Nebelkrähe (*Corvus corone corone* und *Corvus corone cornix*). Wittenberg-Lutherstadt.

WALFORD, N. T. (1931): Carrion-crow building with wire. *British Birds* (London) *24*: 51.

WALSH, W. P. P. (1924): Wire nests. *J. Bombay nat. Hist. Soc. 29*: 1055-1056.

WITTENBERG, J. (1963): Belaubte Zweige als Nistmaterial der Rabenkrähe. *Beitr. Vogelk. 8*: 323-324.

BREEDING AND DEVELOPMENT OF *RANA CYANOPHLYCTIS* SCHNEIDER

P. MOHANTY-HEJMADI AND SUSHIL K. DUTTA[2]

(*With five text-figures*)

The breeding habits and development of the Skipper frog *Rana cyanophlyctis* Schnei der were observed in the populations under natural conditions as well as laboratory maintained ones. Data collected on the development under natural conditions and the development of artificially inseminated laboratory raised tadpoles, showed that in both cases maximum growth in terms of weight and length, occurred during premetamorphic stage. A dramatic decrease, approximately 32% loss in weight and 67% loss in length, occured during the "metamorphic climax" when the tadpole changed into a froglet.

INTRODUCTION

The commonest of Indian Ranidae, the Skipper frog *Rana cyanophlyctis* Schneider is widely distributed over India. They are found in ponds, water reservoirs, ditches and rain water puddles. An excellent description of their habits has been given by Daniel (1975). This study was undertaken to record the breeding habits and development of the Skipper frog found in plenty in Bhubaneswar, Orissa, (Mohanty-Hejmadi 1977 a).

MATERIALS AND METHODS

Observations on breeding behaviour was done in the Vani Vihar, Utkal University Campus area from January till December, 1976. Tadpoles at various stages were collected from a permanent water reservoir of a depth of approximately 46 cm ($1\frac{1}{2}$ feet), as early as 26th April, 1976 before the monsoons arrived. Egg masses, tadpoles and juveniles were collected from temporary and permanent pools of water during the monsoon season from June to August. Tadpoles were also collected in early September. Observations were made at periodic intervals. The larvae were raised in stock tanks (Group-A). Individual variation was seen in length and weight of full siblings at same stage of development. Randomly selected pre-metamorphic tadpoles at same stage of development were separated (Group-B) from stock tanks for study of metamorphosis. These tadpoles were raised in groups of eight in identical finger bowls under conditions standardized in Laboratory (Mohanty-Hejmadi 1977 b). They were fed daily with fish food and vegetable greens. The range of temperature in the laboratory during this period was from 32°C to 41°C. Tadpoles at pre-limb stage were designated as Stage I, with well developed hind limbs as stage-II, upon reaching four-limbed stage as stage-III and after completion of metamorphosis as Stage-IV juveniles. Stage-I, II and III are comparable to the pre-metamorphic, pro-metamorphic and metamorphic climax stages respectively, described by Witschi (1956) for *Rana pipiens*. At stage-III, the tadpoles were transferred into amphibious environment set up as described earlier (Mohanty-Hejmadi 1977 c). The length

[1] Accepted March 1978.

[2] Department of Zoology, Utkal University, Vani Vihar, Bhubaneswar-751 004 (Orissa).

and weight of the tadpoles were taken at periodic intervals. For comparative purpose, tadpoles at Stage-I, II, III and Stage-IV juveniles were also collected from nature. Eggs either from natural spawning in the laboratory or from artificial insemination, were raised through metamorphosis.

Observations

Skipper frogs were seen in both temporary and permanent water pools around Vani Vihar campus throughout the study period. During the winter from November through January, frogs were seen basking in the sun either by sitting on the edges of the pool or by perching on the walls of cemented water tanks. Towards the end of March and in April, a mass migration of frogs occurred during the night from the drying pools to more permanent bodies of water. In a few cases pairs in amplexus were seen.

Since the monsoon did not start until May, tadpoles collected during April, 1976 represented the progeny of frogs who were early breeders taking advantage of the sporadic rains in March, and April. Pre-metamorphic tadpoles were collected even in September indicating that the breeding period lasts from April to September. Since egg masses or embryos were not found in temporary puddles which resulted from sporadic rainfalls during pre-monsoon period, it was concluded that early breeders use permanent water tanks to breed. When the rainfall became more frequent towards the end of May, mature males and females gathered in the evening in rain water puddles, ditches and ponds. They were the leaders of the "amphibian chorus" which was heard both during the day and night. The males and females went into amplexus mostly at night, the amplexus continued throughout the day. Frogs maintained in the laboratory also called, went into amplexus when it rained outside, and even laid eggs spontaneously. Most of the egg masses laid in the laboratory did not grow probably because of the fouling of water resulting from the high concentration of animals in the tanks. However, it was possible to raise tadpoles from one such egg mass.

It is interesting to note that, although pairs in amplexus were seen both during the day and night, in nature as well as laboratory, the ovulation took place only at night. The breeding period lasted from April to September, most of them spawning during the heavy monsoons from middle of June to end of July. The egg masses with 300 to 500 per clutch, were laid in shallow water. The eggs had grayish brown animal pole and pale yellow or white vegetal pole. The diameter of the eggs was approximately 1.0 mm. A week after fertilization, the tadpoles reached a length of 9.25 mm. The characteristic black blotches of the tail (Annandale & Rao 1918; Daniel 1975) appeared when the tadpoles reached a length of about 13.00 mm. Pre-metamorphic tadpoles were occasionally seen eating away dead tadpoles. The Stage-II tadpoles had a mouth disc with one complete row of teeth in the upper lip, and two rows of teeth on the lower lip, and a heavy black serrated beak (Fig. 1).

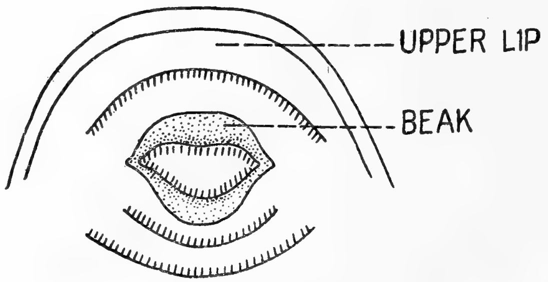


Fig. 1. Teeth structure

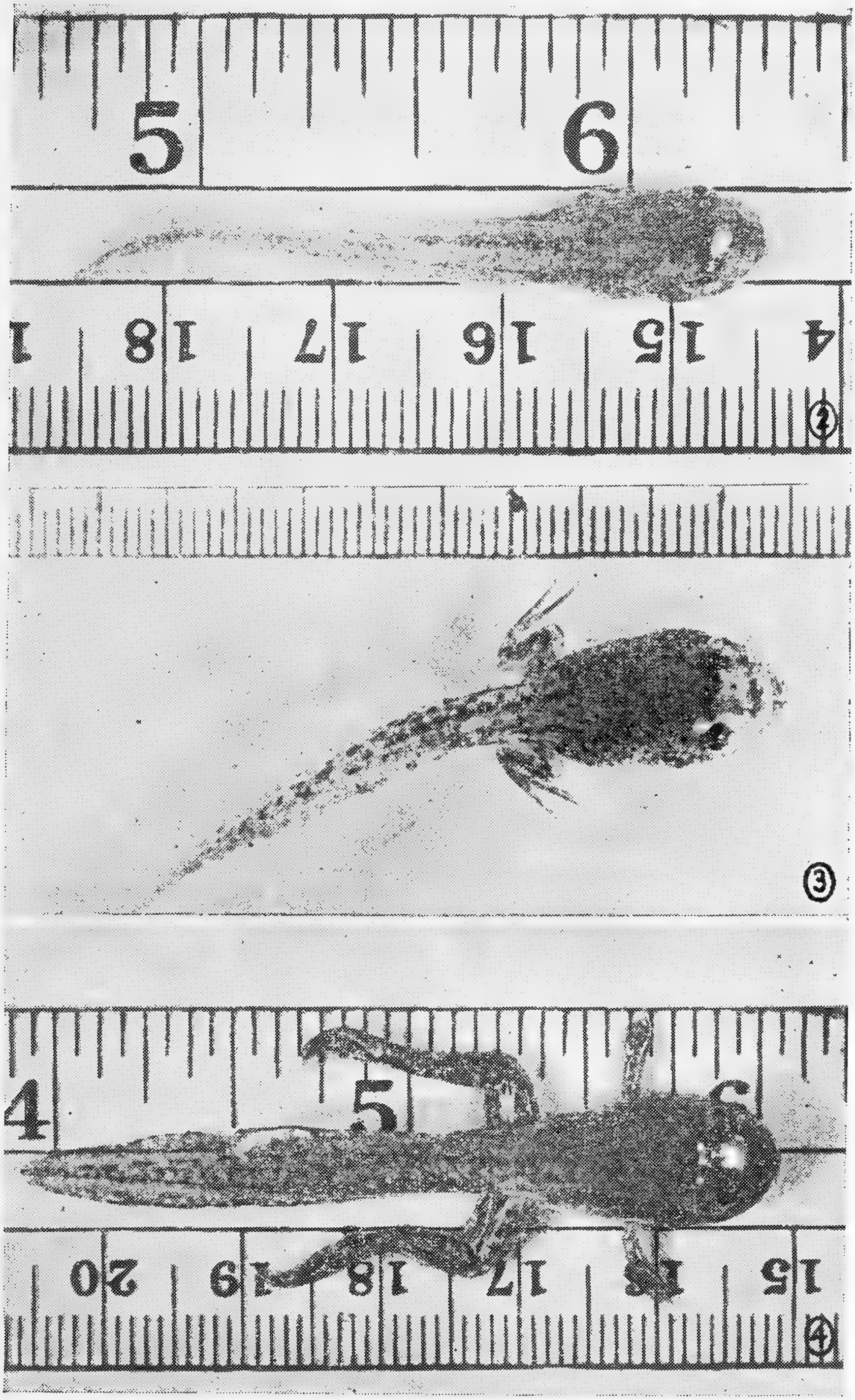


Fig. 2. Pre-metamorphic tadpole. Fig. 3. Pro-metamorphic tadpole.
Fig. 4. Four limbed tadpole at metmorphic climax.

Same teeth structure has been reported by Daniel (1975), which differs from McCann's (1932) observations. According to the diagram given by McCann, there are three rows of teeth in the upper lip and four rows of teeth in the lower lip. The time period for completion of life cycle depended on the conditions under which they were raised. The Group-A tadpoles raised in "Stock tanks" under crowded conditions metamorphosed 15 to 60 days post fertilization. It is interesting to note that four of the stock remained at Stage-II for a considerable period of time. Only one of these four reached stage III in 90 days and completed metamorphosis in 94 days after fertilization. The other three died without reaching Stage-III. In group B tadpoles, the life cycle was much shorter, and there was 100% metamorphosis.

Observations on Group-B Tadpoles:

Towards the end of third week post-fertilization, pre-metamorphic tadpoles (Fig. 2) reached pro-metamorphic (Fig. 3) stage and developed hind limbs. It took fourteen days to complete development of hind limbs. Towards the end of this period the tadpoles reached stage-III (Fig. 4) with the emergence of fore limbs, the right fore limb emerging first in more than 50% of the tadpole observed. The other forelimb emerged within three hours of the emergence of the first. This stage marks the beginning of "metamorphic climax" when several drastic changes occur within a very short period. Stage-III tadpoles took approximately six days to metamorphose completely. Thus the average period of development from egg through metamorphosis was approximately 46 days or six and half weeks in the laboratory.

Between stage-I and stage-II, the larvae developed more pigmented blotches. During the stage-III, the head region became demarcated from the rest of the body. Most of the adult features such as characteristic pigmented spots on the dorsal surface and the webbing of feet developed between stage-III and stage-IV. The mouth shifted from ventral side to the snout and extended upto the sides of the eye. The tadpoles as expected, stopped eating during metamorphosis.

Growth of Gfoup-B Tadpoles during metamorphosis:

Larvae randomly selected at pre-metamorphic stage (Stage-I) ranged from 26 mm to 45 mm with an average of 35 mm in length, and 330 mg to 550 mg with an average of 500 mg in weight (Table-1, Fig. 5). Pro-metamorphic or stage-II larvae ranged from 43 mm to 62 mm with an average of 53 mm in length

TABLE 1 (Fig. 5)

CHANGE IN LENGTH AND WEIGHT DURING METAMORPHOSIS

Stage	Average length in mm	%Change in length from previous stg.	Average weight in mg	%Change in weight from prev. stg
I	35 ± 0.42*		500	
II	53 ± 0.46*	51	1,300	+ 160
III	52 ± 0.25	– 2	1,100	– 15
IV	17 ± 0.18	– 67	750	– 32

(*) Standard error.

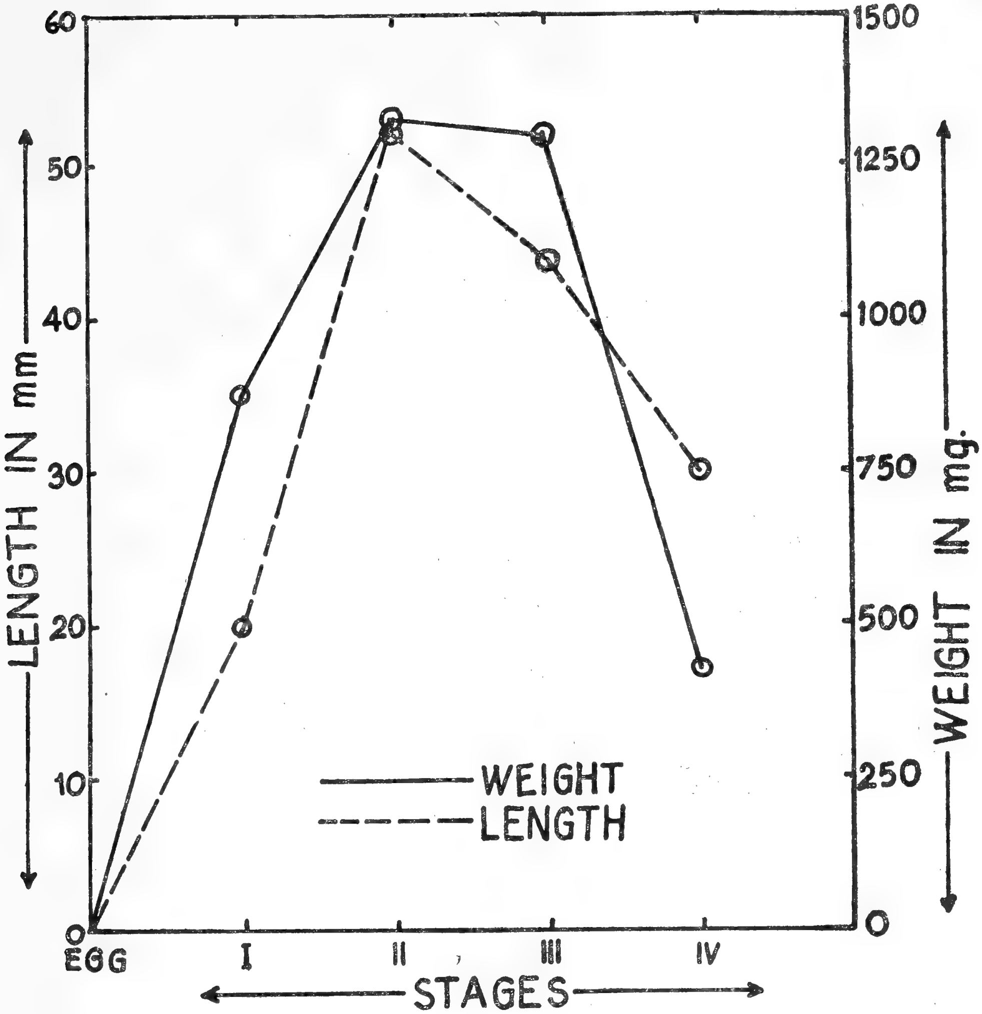


Fig. 5. Growth during metamorphosis.

and from 1333 mg to 1541 mg with an average of 1300 mg in weight. At the beginning of metamorphic climax, stage-III, the larvae ranged from 49 mm to 57 mm with an average of 52 mm in length, and from 1125 mg to 1237 mg with an average of 1100 mg in weight. Newly metamorphosed juveniles ranged from 16 mm to 21 mm with an average of 17 mm in length and from 675 mg to 850 mg with an average of 750 mg in weight. Maximum growth (160%) occurred between stage I and Stage II. Maximum loss in length and weight occurred between stage-III and stage-IV (Table 1). This loss was mainly due to the loss of tail during metamorphosis.

Discussion

The breeding behaviour and development was typically Anuran. Breeding took place mainly during monsoons as reported by other workers (Ferguson 1904: McCann 1932). McCann has indicated about the possibility of *R. cyanophlyctis* breeding at other times under suitable circumstances. Presence of small tadpoles before monsoons would support this view.

There was rapid growth during pre and early pro-metamorphic stage which levelled off at the end of the pro-metamorphic stage. The slight loss during late pro-metamorphosis (Fig. 5) was similar to that reported for other species of Amphibians (Weber 1967). The shorter life cycle in group B in comparison to that of group A was probably due to the lower concentrations of tadpoles in the former. The short time of development, i.e. six half weeks in comparison to other species like 3 months for *Rana pipiens*, or 4 months for *Rana catesbaeana* is probably due to the tropical climate. Stage-I, II and IV larvae collected from nature were consistantly heavier and longer than laboratory raised tadpoles at comparable stages. The difference was probably due to the difference in density, nutrients and temperature as all these parameters affect growth (Richards 1958, Rugh 1962).

The eating of dead tadpoles by pre-metamorphic tadpoles confirms that they are larvivorous (McCann 1932) and probably eat flesh of any dead animal where available. However, true cannibalism was not observed in these tadpoles.

References

Annandale, N. and Rao, C. R. N. (1918): The tadpoles of the families Ranidae and Bufonidae found in the plains of India. *Rec. Indian Mus. 15*: 25-40.

Daniel, J. C. (1975): Field Guide to the amphibians of Western India part-3. *J. Bombay nat. Hist. Soc. 72* (2): 506-522.

Ferguson, H. S. (1904): A list of Travancore batrachians. ibid. *15*: 409-509.

Mohanty-Hejmadi, P. (1977-a): Amphibians of Orissa. *Prakruti—Utkal Univ. J. Science, 11*: 89-97.

——————— (1977-b): Care and management of amphibian embryos. ibid. *11*: 81-87.

——————— (1977-c): Care and management of Indian frogs. Juveniles and adults. ibid. *11*: 75-79.

McCann, C. (1932): Notes on Indian Batrachians. *J. Bombay nat. Hist. Soc. 32*: 152-180.

Richards, C. M. (1958): The inhibition of growth in crowded *Rana pipiens* tadpoles. *Physiological Zoology, 31* (2): 138-151.

Rugh, R. (1962): Experimental Embryology, Burgess Publishing Company, Minneapolis 15, Minnesota.

Weber, R. (1967): Biochemistry of Amphibian metamorphosis. In the biochemistry of animal development II, pp. 227-301, R. Weber edited, Acedemic Press, New York.

*Witschi, E. (1956): Development of Vertebrates, Saunders, Philadelphia, Pennsylvania.

*Original not consulted.

SYSTEMATICS OF THE COMMERCIALLY IMPORTANT PRAWNS (CRUSTACEA, DECAPODA, SUBFAMILY PENAEINAE) FROM GOA[1]

M. J. GEORGE[2]

The taxonomy of the economically important prawns of the subfamily Penaeinae occurring in the waters of Goa is described. Species belonging to 5 genera, namely, *Penaeus* (4 species), *Metapenaeopsis* (1 species), *Metapenaeus* (6 species), *Trachypenaeus* (1 species) and *Parapenaeopsis* (5 species) are recorded. 10 out of the 17 species included are reported for the first time from these waters.

INTRODUCTION

The demands from an export oriented industry increasing day by day, the estuarine and marine penaeid prawn fishery of the country has improved substantially over the past two decades. As a result, all maritime states are making efforts to exploit the fishery to the maximum possible extent. Along with this development, researches indicate depletionary tendencies as a result of over exploitation of a limited resource in certain areas of the Indian coast like, for instance, the Kerala coast (Menon & Abraham 1971). At the same time, there is increasing exploitation of new prawn resources along certain areas on the east coast. It is necessary that research be continued to find out new prawn resources and to keep existing fisheries at maximum sustainable levels. As in other maritime states, along the Goa coast also, the marine penaeid prawn fishery is developing very fast. However, apart from the recent studies on the fishery biology (Anonymous 1975) and the distribution of their larvae in the inshore waters and the estuary (George & Goswami 1976; Achuthankutty *et al.* 1976), no published account is available concerning the systematics of the prawns, which is a necessary prerequisite to determine the exploitable resources in a multi-species fishery. Hence, the opportunity to examine some of the catches of prawns from both inshore, as well as, brackish estuarine waters of Goa was used to report on their taxonomy.

[1] Accepted February 1978.

[2]National Institute of Oceanography, Dona Paula-403004, Goa, India. *Present address*: Central Marine Institute, Cochin-682 018.

LIST OF SPECIES

1. *Penaeus mondon* Fabricius
2. *Penaeus semisulcatus* de Haan
3. *Penaeus indicus* Milne Edwards
4. *Penaeus merguiensis* de Man
5. *Metapenaeopsis mogiensis* (Rathbun)
6. *Metapenaeus brevicornis* (Milne-Edwards)
7. *Metapenaeus dobsoni* (Miers)
8. *Metapenaeus monoceros* (Fabricius)
9. *Metapenaeus alcocki* George and Rao
10. *Metapenaeus affinis* (Milne-Edwards)
11. *Metapenaeus burkenroadi* Kubo
12. *Trachypenaeus curvirostris* (Stimpson)
13. *Parapenaeopsis stylifera* (Milne-Edwards)
14. *Parapenaeopsis cornuta* (Kishinouye)
15. *Parapenaeopsis hardwickii* (Miers)
16. *Parapenaeopsis sculptilis* (Heller)
17. *Parapenaeopsis acclivirostris* (Alcock)

Family PENAEIDAE Aafinesque, 1815
Sub-family PENAEINAE Rafinesque, 1815

Penaeus monodon Fabricius, 1798

Penaeus monodon Mohamed, 1970a : 1258 (with synonymy); 1973 : 551; Muthu 1971 : 154; Racek and Yaldwyn 1971 : 209; Starobogatov 1972 : 387; Ivanov and Hassan 1976a : 246; Kurien and Sebastian 1976 : 100.

Material: Several specimens from the estuary as well as from inshore and off shore catches.

Remarks: The species utilises, to a limited extent, the estuary as a nursery ground only. As a result, the quantity of younger specimens, found in the catches of the estuary is very limited. The large adults are obtained in the mechanised fishery from offshore waters. In the estuary, the species is found mostly in April-May.

Penaeus semisulcatus de Haan, 1850

Penaeus semisulcatus George, 1969 : 23 (with synonymy); Muthu 1971 : 154; Starobogatov 1972 : 368; Mohamed 1973 : 551; Ivanov and Hassan 1976a : 246; Kurien and Sebastian 1976 : 100.

Material: Few specimens from the estuary and the sea.

Remarks: The species is found along with the catches of *P. monodon*, but is rare.

Penaeus indicus H. Milne-Edwards, 1837

Penaeus indicus Mohamed, 1970b : 1274 (with synonymy); 1973 : 551; Muthu 1971 : 154; Starobogatov 1972 : 368; Ivanov and Hassan 1976a : 246; Kurien and Sebastian 1976 : 99.

Material: Specimens from the estuary as well as the sea.

Remarks: All specimens examined show the typical features of the species described in previous literature. The adrostral sulci extend upto the epigastric tooth as described by Alcock (1906), although Racek & Dall (1965) found these sulci slightly exceeding the epigastric tooth. The gastro-orbital carina is well defined. The length of the 3rd pereopod is quite variable as pointed out by Hall (1956). The species occurs in small numbers in both sea and estuary catches.

Penaeus merguiensis deMan, 1888

Penaeus merguiensis George 1969: 24 (with synonymy); Tirmizi 1969 : 757; Muthu 1971 : 154; Racek and Yaldwyn 1971 : 210; Starobogatov 1972 : 368; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 100.

Material: Numerous specimens from the estuarine and marine catches.

Remarks: This is commercially the most important species of the genus present in these waters. It forms an important constituent of the catches from both inside and outside waters. Dall (1957) and Racek & Dall (1965) drew attention to the absence of gastro-orbital carina in the specimens from Australia and New Guinea while the carina is present in specimens from Karachi, Malaysia, Indonesia and the Philippines. The material on hand from Goa waters also shows the presence of this carina occupying middle 1/3 portion between the hepatic spine and area between the hepatic spine and post orbital margin of carapace. Distinction of the species from *P. indicus*, especially in the juvenile stages is very difficult. Muthu & Rao (1973) have described some useful characters for distinguishing the juveniles of these two species.

Genus *Metapenaeopsis* Bouvier, 1905

Metapenaeopsis mogiensis (Rathbun), 1902

Metapenaeopsis mogiensis George, 1969 : 25 (with synonymy); Muthu 1971 : 149; Starobogatov 1972 : 376; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 96.

Material: 3 specimens from the estuary, Ribander area. 42 - 58 mm total length.

Remarks: Considering the differences between Australian and Indian specimens of this species recorded in previous literature, Racek & Dall (1965) remarked that *M. mogiensis* auctorum might consist of more than one species. This has since been proved to be correct and with the material available from Sri Lanka,

De Bruin (1965) separated *P. hilarulus* of de Man (1911) and Barnard (1950) and *M. mogiensis* of Hall (1962) to include them in *Metapenaeopsis hilarulus* (de Man), a view accepted by Muthu (1971) also. Starobogatov (1972) is of the opinion that the specimens of Racek & Dall (1965) are closer to *M. hilarulus*. The present material shows that the specimens belong to *M. mogiensis* auct.

Genus *Metapenaeus* Wood Mason and Alcock, 1891

Metapenaeus brevicornis (H. Milne-Edwards), 1837

Metapenaeus brevicornis George, 1970d : 1564 (with synonymy); Muthu 1971 : 154; Starobogatov 1972 : 389; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 96.

Material: Few specimens from the Zuari estuary and from the sea.

Remarks: This is the first time that the species is recorded south of Bombay on the west coast. The ischial spine is present on the 1st pereopod. Although Kubo (1949) described the telson as devoid of lateral spines, Racek & Dall (1965) observed a pair of clearly perceptible spines near the tip in addition to minute spinules in 24 out of 29 specimens in their collection, a condition described by de Man (1924) and Burkenroad (1934). The specimens in the present collection also show variation in the character, 2 or 3 specimens devoid of the pair of lateral spines on telson while others possessed these spines.

Metapenaeus dobsoni (Miers), 1878

Metapenaeus dobsoni George, 1970a : 1342 (with synonymy); Muthu 1971 : 154; Racek and Yaldwyn 1971 : 212; Starobogatov 1972 : 393; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 97.

Material: Innumerable specimens from the estuary and the sea.

Remarks: This is one of the most important commercial species of the area with reference to quantity of landings. The numerous specimens examined agree with the previous descriptions. The free filament of the petasmal distomedian projection about which attention was drawn by Racek and Dall (1965) is clearly seen in the adult petasma examined. This is one of the species belonging to the group with conjoined white pads on the thelycum in impregnated females.

Metapenaeus monoceros (Fabricius), 1798

Metapenaeus monoceros George, 1970b : 1547 (with synonymy); Muthu 1971 : 154; Racek and Yaldwyn 1971 : 212; Starobogatov 1972 : 389; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 97.

Material: Numerous specimens from the estuary and from the sea.

Remarks: One of the common species in the catches of the estuary, though not very common in the catches from the inshore waters, probably because of the adults occurring in deeper waters than other species as has been reported from the south west coast of India. Trawl nets operated in shallower areas, therefore fail, to trap them.

Metapenaeus alcocki George and Rao, 1966

Metapenaeus alcocki George and Rao, 1966 : 146; George 1969 : 31; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 96.

Material: Few specimens from the estuary.

Remarks: The species is reported for the first time from outside the type locality, the Gulf of Kutch. In the length of the 5th pereopods and mid-dorsal carination of the abdominal somites, slight differences were noticed from the type material. Traces of carination are noticed in the anterior abdominal segments also and the 5th pereopods reach slightly beyond the middle of the scaphocerite.

Metapenaeus affinis (H. Milne-Edwards), 1837

Metapenaeus affinis George, 1970c : 1366 (with synonymy); Muthu 1971 : 154; Racek and Yaldwyn

1971 : 211; Starobogatov 1972 : 368; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 96.

Material: Several specimens from the inshore catches. Only very seldom seen in catches from the mouth of the estuary.

Remarks: The confusion created by Hall's (1962) re-examination of the type material of the species and his comments has since been cleared (Ref: Racek & Dull, 1965, p. 54): Still, there is considerable difference of opinion on the taxonomic status of this species (Mistakidis 1968). Pending a final decision, the two new species of Hall (1962) *Metapenaeus necopinans* and *M. mutatus* are treated as synonyms of *M. affinis.*

Metapenaeus burkenroadi Kubo, 1954

Metapenaeus burkenroadi George, 1969 : 32 (with synonymy); Starobogatov 1972 : 393; Muthu and Manickam 1973 : 214; Mohamed 1973 : 551; Kurien and Sebastian 1976 : 96.

Material: Several specimens from the estuary and rarely from inshore catch.

Remarks: This is the first report of the species from the northern half of the west coast of India, extending its distribution in Indian waters. The species is represented in the fishery of the lower reaches of the estuary and plenty of specimens with mature gonads are seen in the catches in January, February, indicating that the species breeds inside the estuary in these months. Mature specimens of the same species were reported from Pulicat lake by Muthu & Manickam (1973).

De Bruin (1965) recorded some variable features in Sri Lanka specimens. In the present material the dorsal pubescence is less in males than in females as in Sri Lanka specimens. In comparison with De Bruin's specimens the abdominal somites are more pubescent, especially the anterior somites.

Genus *Trachypenaeus* Alcock, 1901

Trachypenaeus curvirostris (Stimpson), 1860

Trachypenaeus curvirostris George, 1969 : 33 (with synonymy); Muthu 1971 : 154; Starobogatov 1972 : 370; Mohamed 1973 : 551; Kurien and Sebastian 1976: 101; Ivanov and Hassan 1976b: 1300.

Material: Few specimens from the sea.

Remarks: In Sri Lanka specimens, De Bruin (1965) found that the rostrum is straight and not curved as illustrated by Dall (1957). Large numbers of specimens examined from the south west coast of India as well as the present material show much variation in this character as noticed by Hall (1961) also. Based on features like straight rostrum and other differences in thelycum and petasma, Ivanov & Hassan (1976b) described 4 specimens from the western Indian Ocean as a new species, *Trachypenaeus starobogotovi*.

Genus *Parapenaeopsis* Alcock, 1901

Parapenaeopsis stylifera (H. Milne-Edwards), 1837

Parapenaeopsis stylifera Rao, 1970: 1580; Starobogatov 1972: 393; Mohamed 1973: 551; George 1973: 421 (with synonymy); Kurien and Sebastian 1976: 98.

Material: Numerous specimens from the sea and a few from the mouth of the estuary.

Remarks: Although the species does not penetrate into the estuary, large numbers are found in the catches from the region of the mouth of the estuary. George (1973) has given the complete synonymy of the species, relegating as synonyms, the two sub-species, namely, *P. stylifera stylifera* and *P. stylifera coromandelica* suggested by Racek & Dall (1965).

Parapenaeopsis cornuta (Kishinouye), 1900

Penaeus cornutus Kishinouye, 1900: 23.

Parapenaeopsis cornuta de Man, 1911: 93; Muthu 1971: 147; Starobogatov 1972: 397; Mohamed 1973: 551.

Parapenaeopsis cornutus Kubo, 1949: 374; Dall 1957: 215; Cheung 1960: 67 (key); Kunju 1967: 1384.

Parapeneopsis cornuta Racek, 1959: 10; De Bruin 1965: 95.

Parapenaeopsis cornuta cornuta Racek and Dall, 1965: 98.

Material: 1 female—48 mm total length from the inshore catch.

Remarks: This is the first record of the species along the west coast of India south of Bombay. Although Hall (1961) suggested that Alcock's *P. maxillipedo* might be considered as geographical variety of *P. cornuta* (Kishinouye), De Bruin (1965) felt that the two are distinct species, based on comparison of the features in Sri Lanka specimens. Racek & Dall (1965) considered them as two subspecies, *P. cornuta cornuta* (Kishinouye) and *P. cornuta maxillipedo* (Alcock). A critical examination of specimens from the south west coast of India and of the present specimen shows that De Bruin's view was correct.

As in De Bruin's (1965) specimens, the 3rd pereopod does not possess basial spine. 2 or 3 pairs of minute spines are present on distolateral margins of the telson. A median tuft of setae is also not present behind the posterior thelycal plate.

Parapenaeopsis hardwickii (Miers), 1878

Parapenaeopsis hardwickii George, 1969: 36 (with synonymy); Muthu 1971: 154; Starobogatov 1972: 370; Mohamed 1973: 551; Kurien and Sebastian 1976: 98.

Material: Several specimens from the estuary and from the sea.

Remarks: The species is recorded for the first time from the west coast south of Bombay. It is also interesting to note that most of the specimens come from the estuary, contributing to the fishery of the estuary to a certain extent in some areas.

The first two abdominal segments are without median carination. The telson is armed with 3 pairs of small lateral spines. The cultrate rostrum of the adult males is a feature shared by both *P. hardwickii* and *P. sculptilis*.

Parapenaeopsis sculptilis (Heller), 1862

Parapenaeopsis sculptilis George, 1969 (with synonymy); Muthu 1971: 154; Starobogatov 1972: 370; Mohamed 1973: 551; Kurien and Sebastian 1976: 98.

Material: A few specimens from the estuary.

Remarks: This species also is reported for the first time from the west coast of India south of Bombay. Occurs in association with *P. hardwickii* which is more common. The specimens of *P. sculptilis* can be separated by the presence of dorso medial carinae on 1st and 2nd abdominal somites, absence of lateral spines on telson and the features of thelycum and petasma as described by earlier authors.

Parapenaeopsis acclivirostris (Alcock), 1905

Parapenaeopsis acclivirostris George, 1969: 37 (with synonymy); Muthu 1971: 154; Starobogatov 1972: 397; Mohamed 1973: 551; Kurien and Sebastian 1976: 97; Ivanov and Hassan 1976b: 1299.

Material: Few specimens from the catches of the sea.

Remarks: Racek & Dall (1965) suggested that the vicinity of Palk Strait on the east coast of India could be considered the zoogeographic boundary separating the eastern species *P. tenella* from its western congener *P. acclivirostris*. Alcock's (1906) record of *P. acclivirostris* from Madras and Visakhapatnam on the east coast of India as well as the recent record of *P. tenella* from East African waters by Ivanov & Hassan (1976b) makes it difficult to accept this suggestion.

KEY FOR THE IDENTIFICATION OF PRAWNS OF THE SUBFAMILY PENAEINAE IN THE WATERS OF GOA

1. Rostrum without ventral teeth 2
   Rostrum with ventral teeth 5

2(1) A distal fixed pair of spines on the telson and 1-3 pairs of mobile spines; petasma asymmetrical; 3rd maxilliped with basial spine .... *Metapenaeopsis*
Stridulating organ absent; hepatic sulcus absent or not reaching to ventral edge of branchiostegite; a pair of tooth-like plate-

lets immediately posterior to thelycal plate; distinct groove present on 3rd abdominal carina; anterior edge of anterior sternal plate between 5th pair of legs in female with 4 rounded teeth, 2 median ones being incurved; distomedian lobule of petasma small .... *Metapenaeopsis mogiensis* (Rathbun)

Distal fixed pair of spines on the telson may or may not be present; petasma symmetrical; 3rd maxilliped without basial spine 3

3(2) No exopod on 5th pereopod; pleurobranch on 7th thoracic somite present............ *Metapenaeus*........ 8

Exopod on 5th pereopod present; pleurobranch on 7th thoracic somite absent...... 4

4(3) 3rd pereopod with epipodite.............. *Trachypenaeus*

Epipodites present on 1st and 2nd pereopods; anterior plate of thelycum may have a raised anterior margin but laterally the margins not raised; an excavation present between the anterior plate and the transverse sternal ridge.......... *Trachypenaeus curvirostris* (Stimpson)

3rd pereopod without epipodite........... *Parapenaeopsis*....13

5(1) Hepatic carina present 6

Hepatic carina absent 7

6(5) Hepatic carina horizontally straight; 5th pereopod without exopodite .... *Penaeus monodon* Fabricius

Hepatic carina inclined at an angle of 20° antero ventrally; 5th pereopod with small exopodite .... *Penaeus semisulcatus* de Haan

7(5) Gastro-orbital carina occupying the posterior 2/3 distance between hepatic spine and orbital angle; rostral crest may be elevated but not triangular in profile.............. ......*Penaeus indicus* H. Milne-Edwards

Gastro-orbital carina absent or not reaching hepatic spine and occupying the middle 1/3 distance between hepatic spine and orbital angle; rostral crest triangular in profile.... .... *Penaeus merguiensis* de Man

8(3) Distomedian petasmal projection with fully developed or vestigial apical filament; thelycum of impregnated females usually with white conjoined pads 9

Distomedian petasmal projection without apical filament; thelycum of impregnated females without conjoined pads..........10

9(8) Posterior part of rostrum with distinctly elevated crest; basial spine on male 3rd pereopod simple; apical petasmal filaments slender, slightly converging; thelycum with a large anterior and small lateral plates.... ....*Metapenaeus brevicornis* (H. Milne-Edwards)

Posterior part of rostrum without distinctly elevated crest; basial spine on male 3rd pereopod long and barbed; apical petasmal filaments not readily visible; anterior thelycal plate tongue-like .... *Metapenaeus dobsoni* (Miers)

10(8) Ischial spine on 1st pereopod distinct 11

Ischial spine on 1st pereopod small or absent 12

11(10) Lateral thelycal plates with salient and parallel ear-shaped lateral ridges; distomedian petasmal projections hood-like....... ...... *Metapenaeus monoceros* (Fabricius)

Lateral thelycal plates without lateral raised ridges; distomedian petasmal projections not hood-like but overlying lateral projections and distally trilobed; posterior extention of the anterior median thelycal plate bound laterally by an oval flat plate on each side ....*Metapenaeus alcocki* George and Rao

12(10) Branchio cardiac carina distinct, extending from posterior margin of carapace almost to hepatic spine; anterior thelycal plate longitudinally grooved, wider posteriorly than anteriorly; distomedian petasmal projections crescent shaped .... *Metapenaeus affinis* (Milne-Edwards)

Branchio cardiac carina feeble or ill-defined, anterior end not exceeding posterior 1/3 of carapace; distal margin of anterior thelycal plate convex to indistinctly triangular; petasma with laminose and strongly diverging distomedian projections .... *Metapenaeus burkenroadi* Kubo

13(4) Epipodites present on 1st and 2nd pereopods; rostrum inclined upwards at an angle to carapace for whole of its length........

......*Parapenaeopsis acclivirostris* (Alcock)
Epipodites absent on 1st and 2nd pereopods 14

14(13) Telson with a pair of fixed sub apical spines; at least distal ½ free portion of rostrum unarmed ....
Parapenaeopsis stylifera (Milne-Edwards)
Telson without fixed sub apical spines, with or without lateral movable spines; 1/3 or less free portion of rostrum unarmed....15

15(14) Petasma with a pair of long slender caliper-like distolateral projections directed forwards; 3rd pereopod of female without basial spine .... *Parapenaeopsis cornuta* (Kishinouye)
Petasma with a pair of distolateral projections directed laterally or distolaterally, short and spout-like 16

16(15) Antennular flagella 0.5-0.6 length of carapace; movable lateral spines absent on telson; thelycum with median tuft of setae on posterior plate ....
.... *Parapenaeopsis sculptilis* (Heller)
Antennular flagella 0.7 length of carapace or longer; movable lateral spines present on telson; thelycum without median tuft of setae on posterior plate ....
.... *Parapenaeopsis hardwickii* (Miers)

ACKNOWLEDGEMENTS

I am thankful to Dr. S. Z. Qasim, Director, National Institute of Oceanography, for facilities and encouragement. Thanks are also due to Dr. K. Radhakrishna, for translation of Russian literature.

REFERENCES

ACHUTHANKUTTY, C. T., GEORGE, M. J. AND GOSWAMI, S. C. (1976): Larval ingression of penaeid prawns in the estuaries of Goa. *Symp. Warm water Zoopl. Spl. Publ. UNESCO/NIO*: 412-424.

ALCOCK, A. (1906): Catalogue of the Indian Decapod crustacea in the collection of the Indian Museum. Part III. Macrura. Fasc. I. The prawns of the *Penaeus* group: 1-55.

ANONYMOUS (1975): Report of the All India Coordinated Research Project 'Studies on marine prawn biology and resources, 1971-1974, CMFRI, ICAR: 1-124.

BARNARD, K. H. (1950): Descriptive catalogue of South African Decapod Crustacea (crabs and shrimps). *Ann. So. Afr. Mus., 38*: 1-837.

BURKENROAD, M. D. (1934): Littoral penaeidae chiefly from the Bingham Oceanographic collection, with a revision of *Penaeopsis* and description of two new genera and eleven new American species. *Bull. Bingham Oceanogr. Coll., 4*(7): 1-109.

CHEUNG, T. S. (1960): A key to the identification of Hong Kong penaeid prawns with comments on points of systematic interest. *Hong Kong Univ. Fish. Jour., 3*: 61-69.

DALL, W. (1957): A revision of the Australian species of Penaeinae (Crustacea, Decapoda, Penaeidae). *Austr. Jour. Mar. Freshw. Res., 9*(1): 111-134.

DE BRUIN, G. H. P. (1965): Penaeid prawns of Ceylon (Crustacea, Decapoda, Penaeidae). *Zool. Meded., 41* (4): 73-104.

DE MAN, J. G. (1911): The decapoda of the Siboga Expedition. Part I. Family Penaeidae. *Siboga Exped. Monograph, 39*a: 1-131.

———— (1924): On a collection of macrurous decapod crustacea chiefly Penaeida. and Alpheidae from the Indian Archipelago. *Arch. f. Naturg., 90* (2): 1-60.

GEORGE, M. J. (1969): Systematics-Taxonomic considerations and general distribution. In Prawn Fisheries of India. *Bull. Cent. Mar. Fish. Res. Inst.* No. *14*: 5-48.

———— (1970a): Synopsis of biological data on penaeid prawn *Metapenaeus dobsoni* (Miers) 1878. *FAO Fish. Rep.,* (57) Vol. *4*: 1335-1357.

———— (1970b): Synopsis of biological data on penaeid prawn *Metapenaeus monoceros* (Fabricius) 1798. *FAO Fish. Rep.,* (57) Vol. *4*: 1539-1557.

———— (1970c): Synopsis of biological data on penaeid prawn *Metapenaeus affinis* (H. Milne-Edwards) 1837. *FAO Fish. Rep.,* (57) Vol. *4*: 1359-1375.

———— (1970d): Synopsis of biological data on penaeid prawn *Metapenaeus brevicornis* (H. Milne-Edwards) 1837. *FAO Fish. Rep.,* (57) Vol. *4*: 1559-1573.

———— (1973): On the penaeid prawn *Parapenaeopsis stylifera* and a new variety of the

species from Cochin. *J. mar. biol. Ass. India,* 15 (1): 420-423.

——————AND GOSWAMI, S. C. (1976): Observations on the larvae of penaeid prawns of commercial importance in the coastal waters of Goa. *Symp. Warm Water Zoopl. Spl. Publ. UNESCO/NIO*: 146-154.

—————— AND RAO, P. VEDAVYASA (1966): A new species of *Metapenaeus* (Penaeidae, Decapoda). *J. mar. biol. Ass. India, 8*(1): 146-151.

HALL, D. N. F. (1956): The Malayan penaeidae (Crustacea, Decapoda) Part I. Introductory notes on the species of the genera *Solenocera, Penaeus* and *Metapenaeus. Bull. Raffles. Mus. 27*: 68-90.

—————— (1961): The Malayan penaeidae (Crustacea, Decapoda) Part II. Further taxonomic notes on the Malayan species. *Bull. Raffles. Mus., 26*: 76-119.

—————— (1962): Observations on the taxonomy and biology of some Indo-West Pacific Penaeidae (Crustacea, Decapoda). *Fish. Publ. Col. off. 17*: 1-229.

IVANOV, B. G. AND HASSAN, A. M. (1976a): Penaeid shrimps (Decapoda, Penaeidae) collected off East Africa by the fishing vessel 'Van Gogh' *Solenocera ramadani* sp. nov. and commercial species of the genera *Penaeus* and *Metapenaeus. Crustaceana, 30* (3): 241-251.

—————— (1976b): On the shrimps of genera *Parapenaeopsis, Trachypenaeus, Metapenaeopsis* (Crustacea, Decapoda, Penaeidae) of the western Indian Ocean. *Zool. Zhur. Academy of Sciences, USSR, 55* (9): 1299-1307.

KISHINOUYE, K. (1900): Japanese species of the genus *Penaeus. J. Fish. Bur., Tokyo, 8* (10): 1-29.

KUBO, I. (1949): Studies on the penaeids of Japanese and its adjacent waters. *Jour. Tokyo Coll. Fish., 36* (1): 1-467.

KUNJU, M. M. (1967): Observations on the prawn fishery of Maharashtra coast. *Proc. Symp. Crustacea, Mar. biol. Ass. India,* Part *IV*: 1382-1397.

KURIEN, C .V. AND SEBASTIAN, V. O. (1976): Prawns and prawn fisheries of India. Hindustan Publishing Corporation (India): 1-280.

MENON, M. D. AND ABRAHAM, K .V. (1971): Inshore shrimp fisheries off Cochin. *Seafood Export Journal, 3* (1): 7-16.

MISTAKIDIS, M. N. (Ed.) (1968): Proceedings of the World Scientific Conference on the Biology and Culture of Shrimps and Prawns. Mexico City, Mexico, 12-24 June 1967. *FAO Fish. Rep.,* (57) Vol. *1*: 1-75.

MOHAMED, K. H. (1970a): Synopsis of biological data on the jumbo tiger prawn *Penaeus monodon* Fabricius, 1798. *FAO Fish. Rep.,* (57) Vol. *4*: 1251-1256.

—————— (1970b): Synopsis of biological data on the Indian prawn *Penaeus indicus* H. Milne-Edwards, 1837. *FAO Fish. Rep.* (57) Vol. *4*: 1267-1288.

—————— (1973): Penaeid prawn resources of India. Proceedings of the Symposium on Living Resources of the seas around India, Special Publication, CMFRI (1967): 548-556.

MUTHU, M. S. (1971): On some new records of penaeid prawns from the east coast of India. *Indian J. Fish., 15* (1968): 145-154.

—————— AND MANICKAM, P. E. S. (1973): On the occurrence of mature specimens of *Metapenaeus burkenroadi* Kubo in the Pulicat Lake. *Indian J. Fish. 20* (1): 214-216.

—————— AND RAO, G. S. (1973): On the distinction between *Penaeus indicus* H. Milne-Edwards and *Penaeus merguiensis* de Man (Crustacea, Penaeidae) with special reference to juveniles. *Indian J. Fish. 20* (1): 61-69.

RACEK, A. A. (1959): Prawn investigations in Eastern Australia. *Res. Bull. New South Wales Stat. Fish., 6*: 1-13.

—————— AND DALL, W. (1965): Littoral penaeidae (Crustacea, Decapoda) from Northern Australia, New Guinea and adjacent waters. *Verh. Kon. Nederl. Akad. Wetensch., 56* (3): 1-116.

—————— AND YALDWYN, J. C. (1971): Notes on littoral penaeinae (Crustacea, Decapoda) from the New Guinea area. *Proc. Linn. Soc. New South Wales, 95* (3): 209-14.

RAO, P. VEDAVYASA (1970): A synopsis of biological data on penaeid prawn *Parapenaeopsis stylifera* (H. Milne-Edwards) 1837. *FAO Fish Rep.* (57) Vol. *4*: 1575-1606.

STAROBOGATOV, Y. I. (1972): Penaeidae (Crustacea, Decapoda) of Tonking Gulf. *Academy of Sciences of the U.S.S.R. Zoological Institute. Exploration of the Fauna of the Seas. 10* (18): 359-415. (in Russian).

TIRMIZI, N. M. (1969): Commercial prawns of west Pakistan. *FAO Fish, Rep.,* (57) Vol. *3*: 749-764.

OBSERVATIONS ON LIFE-HISTORY OF THE PEDUNCULATE BARNACLE, *IBLA CUMINGI* DARWIN[1]

S. N. GAONKAR AND A. A. KARANDE[2]

(*With six text-figures*)

Ibla cumingi Darwin, 1851 is an intertidal pedunculate cirripede found at many places in India. The presence of *I. cumingi* Darwin in the intertidal waters of Bombay had been recently noted. It is a well established species in the low intertidal waters of Madh Island and shares the habitat with another recently discovered barnacle, *Tetraclitella karandei* Ross (Ross 1971). Unlike many other cirripedes *I. cumingi* is a bisexual species. The male, not measuring more than 2 mm, resides in the mantle cavity of the female. This species continues to produce fresh masses of ova throughout the year. However, March, April and May are the active breeding phase. Its smallest size at maturity is 5 mm and individuals measuring between 10-14 mm contribute most towards the growth of the population.

INTRODUCTION

Barnacles constitute a major fouling community and hence interest has been generated in these shell dwelling crustaceans. The nauplii and cyprids of barnacles are being used as test organisms in the assessment of potential antifoulants and the adhesive cement material used by these organisms for settlement has been the subject of considerable interest.

In this Laboratory the breeding habits of several barnacle species including observations on their larvae have been made (Karande & Thomas 1976). In this paper, the breeding behaviour, time and duration of the breeding phase of *Ibla cumingi* are reported so as to facilitate laboratory rearing of this pedunculate barnacle which has been observed to be very convenient for raising larval young, under controlled laboratory conditions.

[1] Accepted July 1978.

[2] Naval Chemical and Metallurgical Laboratory, Naval Dockyard, Bombay 400 023.

MATERIAL AND METHODS

Specimens of *I. cumingi* were collected every month from the rocky shores of Madh Island, from January 1976 to January 1977.

The condition of gonads was determined by microscopic examination and on the basis of development of ovaries, the following five stages of ovarian growth were recognised.

Stage — O	:	Ovarian tissue absent.
Stage — I	:	Lamellae with undeveloped ova.
Stage — II	:	Lamellae with well developed ova.
Stage — III	:	Fertilized eggs.
Stage — IV	:	Encased embryos.
Stage — V	:	Free nauplii in mantle space.

The breeding pattern was judged on the basis of frequency occurrence of the above stages in freshly collected specimens every month.

For raising the larvae of this species in the laboratory, a method described by Karande & Thomas (1971) was adopted.

Observations

Taxonomy:

A short taxonomic description of *I. cumingi* is included for facilitating easy identification.

The number of segments in the anterior and posterior rami of the cirri in the specimen examined is as follows:—

I cirrus—13, 17; II cirrus—23, 25; III cirrus—22, 24; IV cirrus—23, 25; V cirrus—23, 24; VI cirrus—24, 25.

The second to the sixth pair of cirri are alike in shape and structure. Each segment has three pairs of spines on the interior margin and a pair of slender bristles at the distal tip. The caudal appendage is sixteen jointed and reaches above the tip of the pedicel of the sixth cirrus. The mandible (Fig. 1) has three teeth with the lower margins of the large upper teeth non-

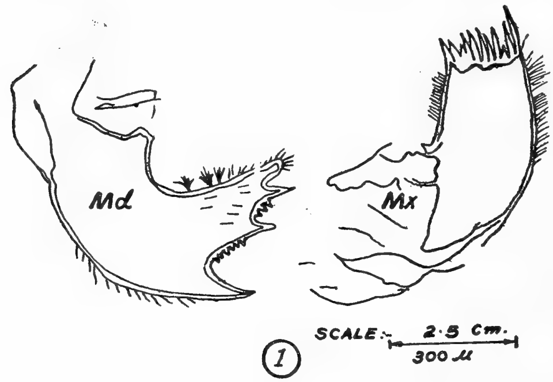


Fig. 1. *Ibla cumingi* Darwin. *Md,* Mandible and *Mx,* Maxilla I.

pectinated and with the upper margins of the second and third teeth pectinated. The upper margin of the second tooth is provided with nine small spines and that of the third with three small spines. Maxilla I (Fig. 1) with the free edge has two depressions. The male is minute with a body length of 1-2 mm. The body is vermiform and whitish in colour. There are two pairs of cirri of which the first pair is four jointed and the shorter three jointed. The maxilla I is with five small spines and a single large spine at the apex (Daniel 1954).

Breeding:

Table 1 shows percentage incidence of *I. cumingi* in relation to different stages of ovarian development over a period of 13 months. The ovarian lamellae are present all through the year in various stages of development.

For a major part of the year, the individuals having mature and maturing ova are of common occurrence. This species continues to produce fresh masses of ova throughout the year. The oogenic activity is continuous throughout the year as is evident by high incidents of ovarian stages I and II.

In December, January and February, when the water temperature is low, a rapid proliferation of the egg lamellae is evident in about 70% of the population. The fertilization of the eggs (Stages III and IV) commences somewhere in the middle of February and in April, a majority of the population, about 68-70%, bears a large number of larvae ready for the release. This period is an active breeding phase in *Ibla cumingi*. During the warmer months of May, June and July, though 70% to 80% of the individuals hold well developed eggs, in the absence of fertilization, the breeding is more or less at a standstill. The fertilization commences again by the end of August and by October a considerable number of individuals bear broods holding developing larvae in the mantle space. The breeding activity is gradually reduced by the middle of November.

I. cumingi individuals measuring between 5 mm and 22 mm were examined every month with a view to determining its smallest size at maturity and for deciding productive phase of life cycle. It will be seen from the data summarised in Table 2, that this species at-

TABLE 1

FREQUENCY INCIDENCE OF VARIOUS OVARIAN GROWTH STAGES IN *Ibla cumingi*

Period of Observation	Stages of ovarian development (Percentages)						Total Fertilized specimens Stages) III to V	
	O	I	II	III	IV	V		
January 1976	16	64	12	4	4	0	8	(360)
February ,,	0	56	20	16	8	0	24	(600)
March ,,	12	20	40	28	0	0	28	(1225)
April ,,	8	4	20	64	4	0	68	(635)
May ,,	8	16	60	8	4	4	16	(270)
June ,,	16	48	36	0	0	0	0	—
July ,,	20	20	48	8	4	0	12	(520)
August ,,	8	12	48	16	12	4	32	(720)
September ,,	12	24	44	20	0	0	20	(630)
October ,,	24	40	0	0	36	0	36	(790)
November ,,	8	8	68	16	0	0	16	(575)
December ,,	8	56	36	0	0	0	0	—
January 1977	28	48	20	4	0	0	4	—

Figures in parenthesis are highest number of larvae counted from a single individual.

tains maturity when it is about 5 mm in length. The individuals measuring between 5 mm and 9 mm (size group I), however, contribute very little towards the growth of the population. This is also true for the individuals coming under size 15-19 mm. Individuals after growing to a body length of 19 mm make no significant contribution towards the production of young larvae.

The individuals coming under size Class II (10 mm to 14 mm) contribute most towards the growth of the population. The continuous development of fresh ovarian lamellae followed by quick embryogenesis and the development of nauplii occur among the individuals of this size group. The highest incidence of developing ova (60%), the highest incidence of fertilized eggs (70%) and also the highest incidence of larvae (68%) are confined to this size group of 10 mm to 14 mm and lend support to this view.

Careful examination of the mantle space of 25 individuals carried out every month revealed that in almost all individuals measuring between 3 mm to 22 mm the male was present. Only in about 4 to 8% individuals the males were not traced. However, this could be due to personal error in locating the males. In about 10% of the individuals examined, two males were simultaneously present in their mantle spaces. A majority of the males pos-

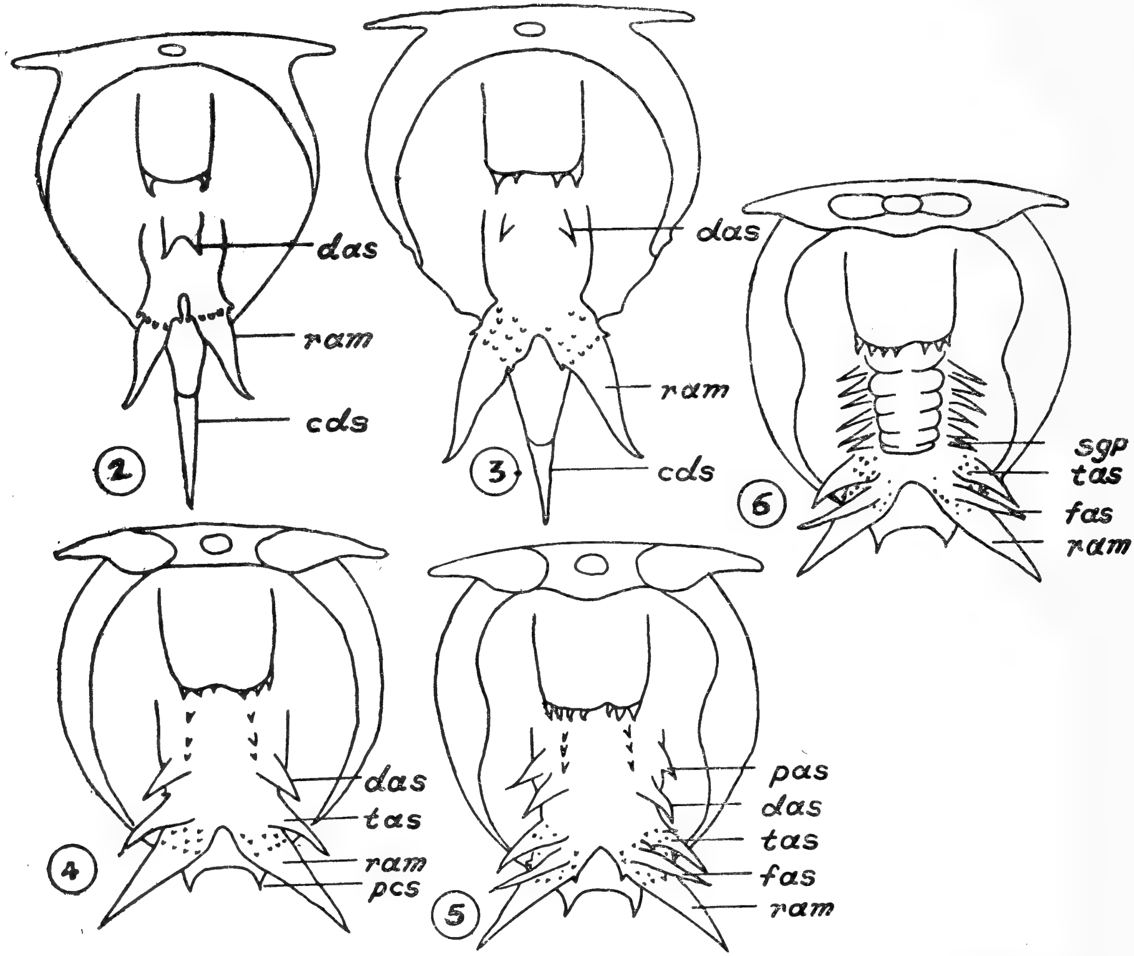
TABLE 2

FREQUENCY OCCURRENCE OF VARIOUS GROWTH STAGES OF OVARY AND LARVAE IN VARIOUS SIZE GROUPS OF *Ibla cumingi*

Size-group mm	Percentage occurrence		
	Early ova	Fertilized eggs	Larvae
I (5-9)	20	23	12
II (10-14)	60	70	68
III (15-19)	19	4	16
IV (19-22)	1	3	4

sess well developed gonadial lobes during most part of the year.

The breeding pattern of the pedunculate barnacle, *I. cumingi* compares generally well with most of the other operculate barnacles, in that there is intense activity during months of February, March and April followed by relatively quiescent phase during monsoon months. A recurrence of breeding in this species is not due to lack of ovarian or male gonadial activity, since well developed eggs and sperms are generally present throughout the year. It is the



Figs. 2-6. Semidiagrammatic outline drawings of the larvae of *I. cumingi* (2-6 represent 2nd, 3rd, 4th, 5th, and 6th nauplius stages respectively and the dimensions in μm respectively are 372, 385, 420, 460 and 500.

Abbreviations:

cds, caudal spine; *das*, distal abdominal spines; *fas*, 4th abdominal spines; *pas*, proximal abdominal spines; *pcs*, posterior carapace spine; *ram*, ramus; *tas*, 3rd abdominal spines.

absence of fertilization during certain times of the year that leads to poor breeding activity. This is observed during the monsoon when along the coast, the water quality particularly with reference to salinity is changing.

Larval stages:

The first nauplius is 300 μm long and like those of other species is pear shaped in appearance. It is the largest first nauplius so far examined from the Bombay waters.

The second nauplius is very fast moving and strongly phototropic. Measuring about 375 μm, it is slightly bigger than the 2nd nauplii of *Balanus amphitrite amphitrite, Chthamalus withersi* and *Ch. malayensis*. Its ill-defined carapace is 300 μm long (Fig. 2).

The third nauplius is 385 μm long (Fig. 3). The frontal filaments are now 45 μm in length. The upper surface of the carapce shows a characteristic sculpturing of brick-work like pattern.

The fourth nauplius measuring 420 μm in length is in many ways different from the preceeding stages (Fig. 4). The total disappearance of caudal process is the most important change noticed. The true carapace, whose frontal and the lateral sides start sloping towards the mid axis of the body, shows a pair of 40 μm long posterior carapace spines.

The fifth larva measuring 460 μm in total length appears different from the 4th larva in many respects (Fig. 5). The 385 μm long and 335 μm wide carapace shows pronounced inward slope at its free margin. The 160μm long labrum is a massive organ and generally bears 7-8 teeth and numerous hairs on its free margin. The abdominal area grows very bulky and the cirral appendages in the form of ill-defined papillae are seen under the exoskeleton.

The sixth larva or the metanauplius is 500 μm long (Fig. 6). Its carapace is 420 μm long and 360μm wide. The 150 μm long labrum continues to be a massive structure that retains all 7 or 8 teeth and the hair. The abdomen is very broad and bulbous and has 6 pairs of segmental spines. These spine are broad and bulbous at the bases and acutely pointed at their free ends.

The cyprid larva emerges at the end of ten days development. Its boat-shaped carapace is 565 μm long and 250 μm wide. A large number of oil/fat droplets of about 25 μm diameter are seen under the carapace. The antennular adhesive pad is of 30 μm diameter. Each ramus of cirral appendages has four segments and about 120 μm long cirri. The cirri of the first appendages are stouter than those of the appendages which appear subsequently. The subterminal segment of each ramus of 6 appendages bears a short but a distinct hook like spine.

Remarks:

I. cumingi as compared to other operculate species encountered along Bombay coast is a poor breeder. For the whole one year several individuals were examined and the numbers of larvae held in their mantle space were individually counted in this and five other species. The highest numbers of larvae counted in a single brood of *B. a. variegatus, B. a. amphitrite, T. karandei, Chthamalus withersi, Ch. malayensis* and *I. cumingi* were 35000, 18700, 5900, 7000, 4300 and 1200 respectively. Despite this limitation of the number of larvae, it is felt that, *I. cumingi* is a handy material to raise the larvae under controlled laboratory conditions.

References

Darwin, Ch. (1851): A monograph of the subclass Cirripedia, I, Lepadidae, London.

Daniel, A. (1956): The Cirripedia of the Madras Coast. *Bull. of the Madras Govt. Museum. New Series Nat. Hist. Section,* Vol. VI. No. 2.

Karande, A. A. and Thomas, M. K. (1971): Laboratory rearing of *Balanus amphitrite communis* D. *Curr. Sci. 40* (5): 109-110.

——— & ——— (1976): The larvae of the intertidal barnacle *Chthamalus malayensis* Pilsbry. *Proc. Ind. Acad. Sci. Vol.* LXXXIII, Sec. 'B' No. 5: 210-219.

Ross, A. (1971): Studies on the Tetraclitidae (Cirripedia: Thoracica): A new tetraclitellan from India, *San Diego Soc. Nat. Hist., Trans. 16* (8): 215-224.

PREDATION ON NATURAL NESTS OF THE SALT-WATER CROCODILE (*CROCODYLUS POROSUS* SCHNEIDER) ON NORTH ANDAMAN ISLAND WITH NOTES ON THE CROCODILE POPULATION[1]

B. C. Choudhury[2] & H. R. Bustard[3]

(*With five plates and two text-figures*)

During June/July 1978 a quantitative study of saltwater crocodile nests and nest predation was carried out in North Andaman. Predation was found to be extremely higher, twentyeight of thirty nests (93.4%) were destroyed by predators and a further nest was completely flooded, giving a 3.3% hatching success. Human predation accountd for almost all nest predation (84.6%). Nests occurred predominantly in the creeping cane/evergreen vegetation zones. Data are presented on the ecology of nesting and compared with data from elsewhere in the species' wide geographical range.

Active nest hunting by settlers, together with killing of adult crocodiles—often the nest-guarding female—combined with data on the remaining adult population gives cause for great concern for the future of this population of an endangered species.

Introduction

Precise scientific data on saltwater crocodile nests has been lacking until recently (Neill 1971) although the natural history has been known in outline for a long time Deraniyagala (1939). The recent paper by Webb *et al.* (1977) is an important contribution. However, it deals with a typically Northern Australian situation which is very different from the Indian situation. In Northern Australia flooding is a major nest hazard, but predation, both human (by aborigines) and by wild life, is invariably extremely low.

During the latter part of the 1978 egg laying season approximately four weeks (22nd June to 16th July) were spent in the crocodile habitat of North Andaman observing nests. Data were collected on a total of thirty nests in which eggs had been laid, as a result of personal observation, or readily checkable information, collected on nests from reliable sources. This paper gives an account of nest predation together with information on the crocodile population of North Andaman.

North Andaman (Fig. 2), with a total area of 1376 sq km is one of the five main islands which form the Andaman group. The Andaman Islands (10° 13′—13° 30′N and 92° 15′—93° 10′E) lie in the Bay of Bengal. The northernmost major island of the Andaman group, North Andaman, lies at a distance of 896 km south-east of the mouth of the Hoogly (Ganges) and at a distance of 192 km south of Cape Negaris in Burma. The main mass of North Andaman is roughly hexagonal in outline with a maximum length of 77 km from North to South and maximum width of 29 km from East to West. North Andaman Island

[1] Accepted February, 1979.

[2] Research Scholar, Andhra Pradesh Forest Department Crocodile Conservation Project, Nehru Zoological Park, Hyderabad.

[3] FAO Consultant, Government of India Central Crocodile Breeding and Management Training Institute, Lake Dale, Hyderabad 500 264.

is separated from Middle Andaman by a narrow sea water creek known as Austin strait.

The study area, together with the rest of the Andaman-Nicobar Group, comprises one of the three last remaining saltwater crocodile habitats in India—the other two being Sundarbans in West Bengal and Bhitar Kanika at the Brahmini-Baitarni delta in Orissa.

Study area

The coastline of the study area is highly indented and at many places penetrates deeply into the island landmass to form island bays and deep creeks. Most of the rivers and streams empty into these creeks.

In the South of North Andaman, Kalara, Balmi, and Parangara creeks, in the East, Kalpang River and its tributaries, and in the West the streams that empty into the Casurina and Hudson Bay, were the major areas where extensive field work was carried out (Fig. 2). These creeks and streams form the major saltwater habitat in North Andaman.

All these creeks are fringed by belts of mangrove swamps (Plate I) which are regularly inundated during the high tide. Over the years, forests on both banks of the Kalpang River have been cleared and settlements are growing. This river was formerly a good habitat for saltwater crocodiles.

The creeks along the East coast of North Andaman are deep, those along the West coast shallow, about nine and three metres respectively, at mean tide level, the latter creeks (Plate I) with pebble beds. There are two tides every twentyfour hours inundating the banks of the streams. The tide fluctuation in the creeks is above 2 mts.

In the undulating terrain and thick tropical forests of North Andaman communication depends entirely on the open sea and inland creeks. This results in a certain amount of disturbance. Other than transport, fishing, crabbing and cutting of cane, bamboo and mangrove trees along the creeks, also creates some disturbance.

Climate:

The study area lies south of the Tropic of Cancer between 12°50′ to 13°13′N and experiences a tropical climate, warm and moist throughout the year except for a cool period during December and January. The location subjects it to the South-West monsoon from the beginning of May to the middle of October and the North-East monsoon from the middle of October to mid-December.

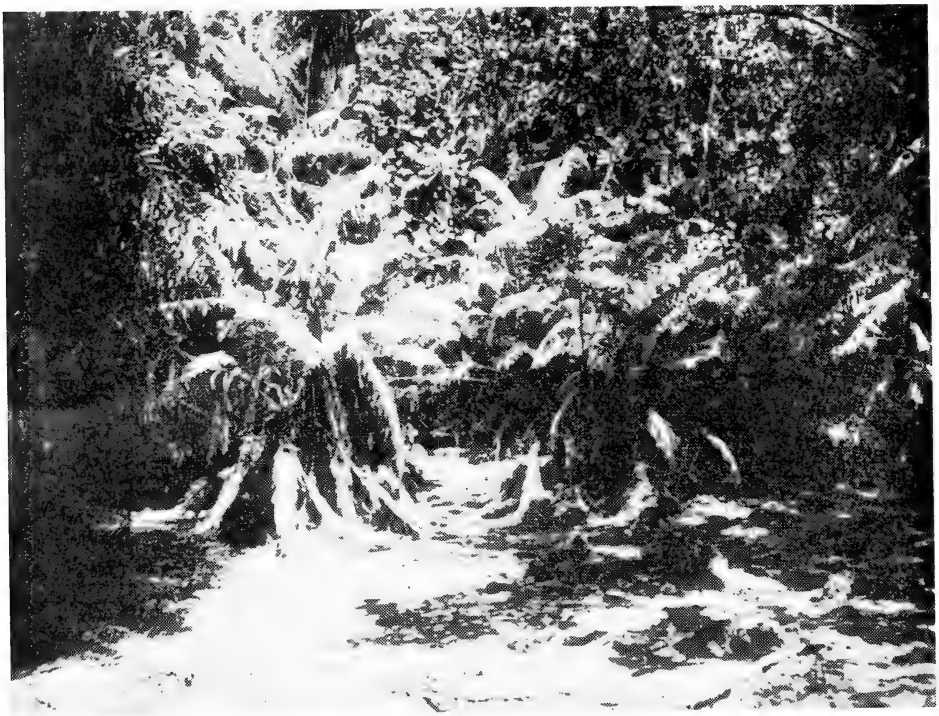
North Andaman receives less rainfall than Middle and South Andaman. The average annual rainfall recorded at Mayabundar, the northern most part of Middle Andaman is 216 cm. Because most of the landmass of North Andaman lies on the lee side of Saddle Peak (737 mts) it receives less of the South-West monsoon.

The mean maximum/minimum temperatures for North Andaman are 27.7°C/24.3°C respectively and humidity is relatively high at 80% (Lal 1976).

Vegetation:

The vegetation along the streams and creeks can be classified into three distinct types; zone 1: tidal mangroves (Plate I), zone 2: standing cane, sometimes associated with bamboo brakes, (Plate II), zone 3: low level evergreen, riverine forests along the banks of the streams (Plate II). All these three vegetational types occur within 300 mts of a high water mark. The stratification from coastal mangroves (foreground) to the evergreen forests (background) is clearly illustrated in Plate III. Settlements have been established on the upper reaches of the streams due to availability of fresh water, and forests have been cleared to provide cultivated land.

Above: Typical mangrove vegetation along the Kalpang River, East coast of North Andaman. *Below*: Typical, shallow, West coast, creek with pebble bed providing excellent habitat for *C. porosus*.



Above: Zone III. Creeping cane, in this case associated with bamboo brakes, inland from the main river. Note the firm ground in this vegetational zone not usually liable to flooding. *Below*: Zone III. Creeping cane/evergreen forest complex at the head of a side creek. It is in this zone that most of the nests occur.

Rhizophora mucronata and *Rhizophora apiculata* are the major plant species bordering the creeks with a height of 10 mts or more. Immediately behind this zone follows *Brugviera parviflora* and *B. gymnorrhiza* with an undergrowth of *Ceriops tagal* (Blasco 1977). This zone is called *Khals* (Bengali) by the East Bengal settlers living in North Andaman.

The transitional zone of the tidal mangroves and the riverine forests forms a belt of cane brakes which is most important in the present context as this is the best nesting habitat for saltwater crocodiles in North Andaman. *Calamus andamanicus* and *Calamus palustris* dominate this belt. Creeping cane, is also present in this region. In the next zone of semi-evergreen and evergreen climaxes, dense clumps of bamboo *Oxylenanthera nigso-ciliata* occurs with scattered trees of *Dipterocarpus incanus. Planchoria andamanica, Pinsonia exelsa* etc. Actually the cane brakes and semi-evergreen climax zone is a continuous zone which has been divided here for convenience.

Materials and methods

Nests were located with the help of boats or by walking along the river and stream banks. Local people also assisted in showing areas where nests had been seen by them in previous years. Wherever the nests were located incidence of egg robbing, flooding and predator damage were noted. Measurements of nest dimension, its position in relation to permanent water, physical surroundings, vegetation in and around the nest, presence of wallows around the nest and presence of nesting female near the nest, were also noted irrespective of the condition of the nest.

Results

The Nest:

The members of the Order Crocodylia lay their eggs in one of two nest types. These are, hole nests and mound nests. In hole nests eggs are laid in a pit dug in dried mud-banks or sand. In mound nesting, rather like Megapode birds, the eggs are laid in the middle of a nest mound prepared with vegetation and mud. Eggs are deposited in a cavity dug in the central area of the elevated nest mound. The saltwater crocodile is a mound nester.

In the study area, the saltwater crocodile nests observed were made of vegetation and mud. The nest mound was circular in appearance with an elevated centre. Since ten, of fifteen nests personally inspected, had already been opened by humans no precise measurements of these nests could be taken. Of the remaining five nests, two opened by wild pigs also had a similar appearance. Only the two Monitor-predated nests, and one flooded nest, from which eggs were collected, were measured. Measurements were also taken of a nest made and abandoned in a wild sugarcane fringe. These three nests averaged about 75 cm in height and 2 mts. in diameter at the base.

The nests were observed to have been made in three types of vegetation zone. These are, tidal cane fringes, creeping cane and evergreen vegetation and cultivated land. In the tidal cane fringes, where four nests were observed (Table III), the nests were made of standing canes; *Calamus* sp. with a higher percentage of mud in the nest construction. The distance of the nearest permanent water varied considerably since the areas were inundated by the high tide. The surface around such nests was

mostly swampy with a certain depth (about 15 cm) of water present all the time. Since the nests were made mostly on the elevated bases of old cane clumps, they were at a higher level to the surrounding ground.

In the next nesting zone, proceeding further inland from creek-bank—the creeping cane and evergreen vegetation zone—ten nests were observed. The ground in this region was solid and dry. The vegetation used in nest making was mostly creeping cane and dry fallen leaves of evergreen trees. These nests had very little mud in them. The nearest permanent water (streambed) was as close as five mts. in some cases. A typical undisturbed nest in this zone is shown in Plate IV. The nest, opened to show the eggs, is shown in Plate IV. The presence of people gives a good idea of the physical size of the nest. In the third nesting zone of cultivated land along the freshwater streams and creeks, only one nest was observed. This nest was made of grass and miscellaneous shrubs without mud.

The nests observed were invariably close to water. Due to the influence of tides, the water mark on the banks also changed, and as such it was not possible to correctly measure the distance of permanent water from the nest. The distance of permanent water from the creeping cane/evergreen vegetation fringes varied at mean tide level from 5-50 mts.

The nests made in tidal can fringes were in shade all the time with the canopy of canes covering the nests. The nests in creeping cane and evergreen vegetation zone were on the forest edge thus exposing the nest to light for some part of the day.

The single nest observed in the cultivated land and the abandoned nest in the wild sugarcane fringes were both totally exposed with no protection from sun, wind and rain.

The presence of wallows near the nests was also recorded. Except for one nest in the cultivated land and one nest in the evergreen forest region, upstream from a creek, wallows were observed in all other nests. From a single wallow to as many as three were seen near the nests. The wallows near the tidal cane fringe nests were not very deep but the wallows in the creeping cane/evergreen forest fringe nests were deep. Wallows in the two habitats measured as follows: (a) tidal cane fringes (four nests observed with nine wallows: mean length, breadth and depth are followed by range in brackets 161.2 (105—185), 74.9 (63—90), 46.8 (35—65), (b) creeping cane/evergreen forests complex (nine nests observed with seventeen wallows) 176.0 (135—223), 81.6 (58—108), 113.2 (65—155). The difference in depth between the two habitats is significantly different.

Before any attempt was made to inspect the nests closely, the wallows were disturbed with long poles to note the presence of nesting females. Of the fifteen nests observed, nesting females were seen at three of them, one of which had the eggs intact, one had been predated by *Varanus* but the nest shape remained intact (Plate V) and the third nest had been destroyed by humans, and at another nest, also destroyed by humans, an adult was observed in the water of the creek close to the nest. Additionally, tracks, believed to be those of the nesting females, were seen at six of the nests. Though many of them seemed to be fresh, the last visit of the nesting female to the nest could not be ascertained with certainty. Thus nest-guarding was taking place, or could be inferred, at ten of the fifteen nests. It is noteworthy that at the nest from which eggs were collected and the female was present in the adjacent wallow the mother crocodile meekly ran into the water after once being poked with a long pole.

Above: A view of the East coast from the open sea. The fringing mangroves are clearly visible, and behind and towering over them, the darker vegetation of the evergreen forests. Between these are the transitional tidal cane fringes. *Below*: Mangroves, completely felled and cleared, on the West coast, for use as fuel and for house construction.

Above: An undisturbed saltwater crocodile nest (the only one encountered during the study) in creeping cane/evergreen forest, Zone III, on the West coast. *Below*: The same nest opened to expose the eggs. This plate gives a good impression of the size of the nest, here mostly constructed of creeping cane and dry, fallen, leaves of evergreen forest trees.

Nest predation

Of the thirty nests studied only one gave rise to hatchlings (Table 1).

Table 1

Hatching of Natural Nests of Saltwater Crocodile (*Crocodylus porosus*) at North Andaman Island.

Number of nests	Number hatched	Number destroyed by predators	Number flooded
30	1 (3.3)	28 (93.4)	1 (3.3)

(Figures are followed by percentage in brackets).

This results from an high incidence of nest predation, almost entirely by humans (Table 2).

Table 2

Incidence of Nest Predation

Number of nests	Predators			
	Humans	Monitors	Wild Pigs	Undetermined
26	22 (84.6)	2 (7.6)	2 (7.6)	2 (7.6)

(Figures are followed by percentage in brackets).

Wherever, humans have taken the eggs clear evidence of clearing of bushes, canes etc., using sharp cutting instruments and complete destruction of the nest mound was observed. In case of wild pig predation, the nest mound was spoiled (Plate V) and hoof marks were clearly visible on the cleared vegetational area around the nest. The most clearly ascertained predation was that by Monitor lizards (*Varanus*). Fresh tracks as well as the tail marks with a few scattered egg-shells around a perfect nest with neat holes (Plate V) indicated the presence of *Varanus*. A Monitor Lizard was seen close by one of the two nests which had been predated by *Varanus* (Table 2). This nest also had the nesting female crocodile lying in one of the wallows on one side of the nest. The *Varanus* had made a neat hole in the opposite side and eaten all the eggs (on opening the nest no more eggs remained).

Non-human predators may not eat all the eggs. However, when the egg mass is exposed by a predator, the micro-environment of the nest, essential for incubation, is destroyed. Hatching of any of the remaining eggs is, therefore, unlikely. The nests observed with one exception (Table 3) were restricted to two vegetational complexes. No nests were observed in the mangroves at the mouths of the creeks. In these two types of vegetational complexes, namely tidal cane and creeping cane/evergreen forests, more than two-thirds of the total nests occurred (Table 3).

The break-up of nest predation in the nests personally observed in the various habitats is given in Table 4. Humans frequent both of the main nesting habitats, wild pigs are mostly in the creeping cane/evergreen vegetation and monitors favour the tidal cane fringes since they search for small invertebrate and vertebrate prey in the areas subject to inundation.

Table 5 analyses the human predation on eggs in the nesting habitats.

Crocodile population

Data on the naturally occurring crocodile population were recorded during the course of this study. However, no night survey work was carried out for census determination purposes.

A female observed with her brood of young

TABLE 3

NEST LOCATION IN RELATION TO VEGETATION COMPLEX

Number* of nests	Location of nest			
	Mangroves	Tidal Cane Fringes	Creeping Cane and Evergreen Vegetation	Cultivated land along the fresh water streams
15	-	4 (26.6)	10 (66.6)	1 (6.6)

(Figures are followed by percentage in brackets).

* These fifteen nests were all personally inspected.

TABLE 4

PREDATION IN RELATION TO VEGETATION COMPLEX

Vegetation complex	Predator				
	Humans	Monitors	Wild Pigs	Undetermined	Total
Tidal cane fringes	4 (26.6)	2 (13.3)	-	-	6 (40)
Creeping cane and evergreen vegetation	4 (26.6)	–	2 (13.3)	2 (13 3)	8 (53.4)
Cultivation lands along the fresh-water creeks	1 (6.6)	–	-	–	1 (6.6)
Total	9	2	2	2	15

(Figures are followed by percentage in brackets).

TABLE 5

TYPE OF HUMAN HUNTING ACTIVITY

Number of nests taken by humans	Type of human hunting activity	
	Deliberate hunting for eggs	Chance encounters of crocodile nests
22	19 (86.3)	3 (13.7)

(Figures are followed by percentage in brackets).

measured about 2.7 mts. Two nest-guarding females also measured approximately 2 mts. A third nest-guarding female measured approximately 3.5 metres.

Four crocodiles were sighted in the open water. Two measured approximately 3 to 3.75 mts and two were in excess of 4.5 mts, one of which measured about 6 mts. Apart from these eight adults, six juvenile crocodiles measuring not more than 1.2 mts were sighted in the creek emptying into Casurina Bay on

Above: A nest destroyed by wild pig. Note that the nest shape has been completely lost and the debris scattered over a wide area. *Below*: A nest preyed upon by monitor lizard. The nest retains its shape and access to the eggs is gained through a well defined hole. Two wallows can be seen behind the nest on left and right.

the West Coast, and a cluster of approximately twentyfive recent hatchlings was sighted in the company of their mother at a creek on the west coast.

The crocodiles actually sighted are given according to size/age class group in Table 6.

TABLE 6

DIFFERENT SIZE/AGE CLASSES OF SALTWATER CROCODILES SEEN IN NORTH ANDAMAN

Number of crocodiles seen	Adults			Hatchlings	Yearlings/Second years
	Nesting females	Other adults	Total		
39	4	4	8	Approx.25 in one group	6

Further insight into the population structure can also be obtained from an examination of clutch size data, since clutch size in saltwater crocodiles increases with increase in length/age females. Precise data are available for six nests from this study and cross-checked reports of clutch size for further five nests (Table 7 and Figure 1).

TABLE 7

CLUTCH SIZE OF SALTWATER CROCODILE IN NORTH ANDAMAN

Cluth size*		Mean (all nests)
Confirmed	Unconfirmed	
55	39	
60	39	
42		
42	39	46.1
42	69	
67	19	
Mean 51.3	Mean 41.0	

* During 1976 June one nest collected from North Andaman had 51 eggs, and during the latter part of June/July 1976 another nest with 72 eggs was also observed by Whitaker (1978).

Adult Losses:

During the nest survey information on killing of nesting females was also collected. A total of five nesting females were reported to have been killed during the 1978 nesting season. Of these killings four were reported from the west coast (Casurina and Hudson Bay) where encroachment on forest land along the fresh water streams is very high. Activities such as bamboo and cane cutting, crabbing and fishing are also high. One nesting female was reported to have been killed on the Kalpang river in an area of cultivated land (but outside the cultivation season). All these females were reported to have been of less than three metres in size.

DISCUSSION

Whitaker and Whitaker (1978) have stated that North Andaman nests are susceptible to flooding and predation, especially by the water monitor (*Varanus salvator*). These observations are not borne out by the present quantitative study also in North Andaman. While it is true that nests of saltwater crocodiles tend to be susceptible to flooding, the building of two-thirds of the nests in the cane/creeping cane, evergreen forest interphase area reduces this most effectively. Only one nest (3.3%) was lost from this cause (Table 3).

Flooding was the major cause of the nest loss in Webb *et al.*'s (1977) study in which

twentyfour of thirty nests under study were flooded. However, data have to be collected over a number of years. In the Northern Australian environment due to marked variations in the severity of floods Bustard (unpublished data) arrived at an annual, average, nest loss, due to flooding, of about 50% for the West coast of the Cape York peninsula in North Queensland, Australia, in the vicinity of Edward River. In the present Andaman study of the fifteen nests personally inspected only one was flooded. However, the eggs were taken by people from most nests before they had a chance to be flooded. Incidence of flooding might, therefore, have been much higher in the absence of this very high level of human predation. However, even making allowance for this we do not anticipate a level anywhere

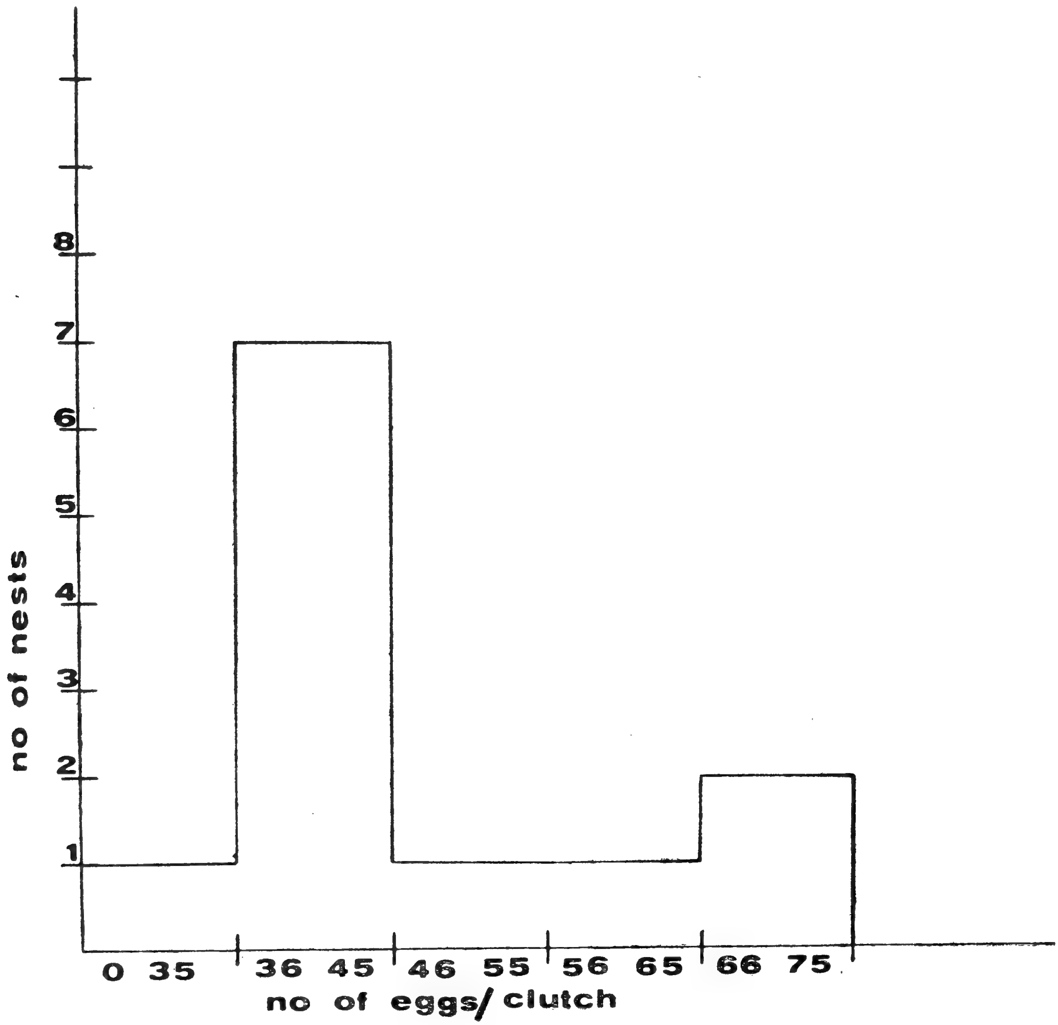


Fig. 1. Clutch size variation. Note 36—45 eggs is the most common range of clutch size.

approaching the Australian figures quoted by Webb *et al.* (80% of nests lost through flooding).

Webb *et al.* also record absence of nests from the tidal mangrove forests. There would appear to be good reason for this due to the high probability that nests laid in this environment would be flooded. Webb *et al.* give the mean distance of fifty nests from the water as 7.8 metres but agree with our observation that this distance is difficult to measure and somewhat arbitrary due to tidal fluctuations.

The mean dimensions of the three nests examined in the present study are considerably larger than those given by Neill (1971) for the Philippines, several parts of Indonesia and Papua (height 25-30 inches, diameter 4-5 feet), and the mean figure given by Webb *et al.* although our figures are well within the range observed by the latter authors.

Surprisingly, Neill (1971) dismisses the presence of nest wallows thus:

> "According to the Ceylonese legend, the female estuarine crocodile scoops out two basins near her nest, waits until these basins are full of water, and then with her tail splashes this water over the nest. It is easy to see how the legend of the two basins could have developed: the female uproots and scrapes up vegetation from a small area in which her nest will be located, and in so doing might easily leave depressions in which rainwater or seepage could accumulate."

With the exception of two nests, one to three wallows were always present in the present study. Bustard has also noted the invariable presence of wallows elsewhere in India and in Australia. Webb *et al.* also noted the presence of one to four wallows and raised the interesting question that these could be of two origins. While some might have been created by sweeping up mud and debris for nest construction as suggested by Neill, some, they state, appeared to have been excavated specifically for the crocodile to lie in. They noted, and this is the important point, that the nest-guarding crocodile occupies both types of wallow, an observation with which we concur. We confirm that the saltwater crocodile regularly lies in wallows close to the nest, both in the wild and in captivity (Bustard and Maharana in preparation).

The function of the wallow deserves discussion. We consider that they may play a role in thermoregulation—particularly where the nest is exposed to direct sunlight for part of the day. We also feel that wallows may have an important psychological effect for this very aquatic crocodilian. In this connection we would stress the role of the larger wallows—clearly constructed specifically for the crocodile to lie in as suggested by Webb *et al.*—since they are frequently many times larger than the total volume of nest material, so that Neill's suggestion that they occur as a by-product of nest construction is untenable (see Figure 2 of Webb *et al.* for a clear illustration of this). In these latter wallows, the crocodile can lie completely unseen, giving it a psychological advantage, and certainly a feeling of security. Further substantiation of this hypothesis comes from the fact that the wallows in the creeping cane/evergreen forest zone are deeper and longer compared to those in the tidal cane fringes. This increased depth is necessary in this drier zone to ensure a good supply of water. Incidentally, Deraniyagala (1939) also refers to the presence of nest wallows in Sri Lanka.

The mean clutch size observed by Webb *et al.* (1977) was fifty eggs (range 40 to 62). Neill (1971) gives a range of twentyfive to seventytwo. Our own observations for North

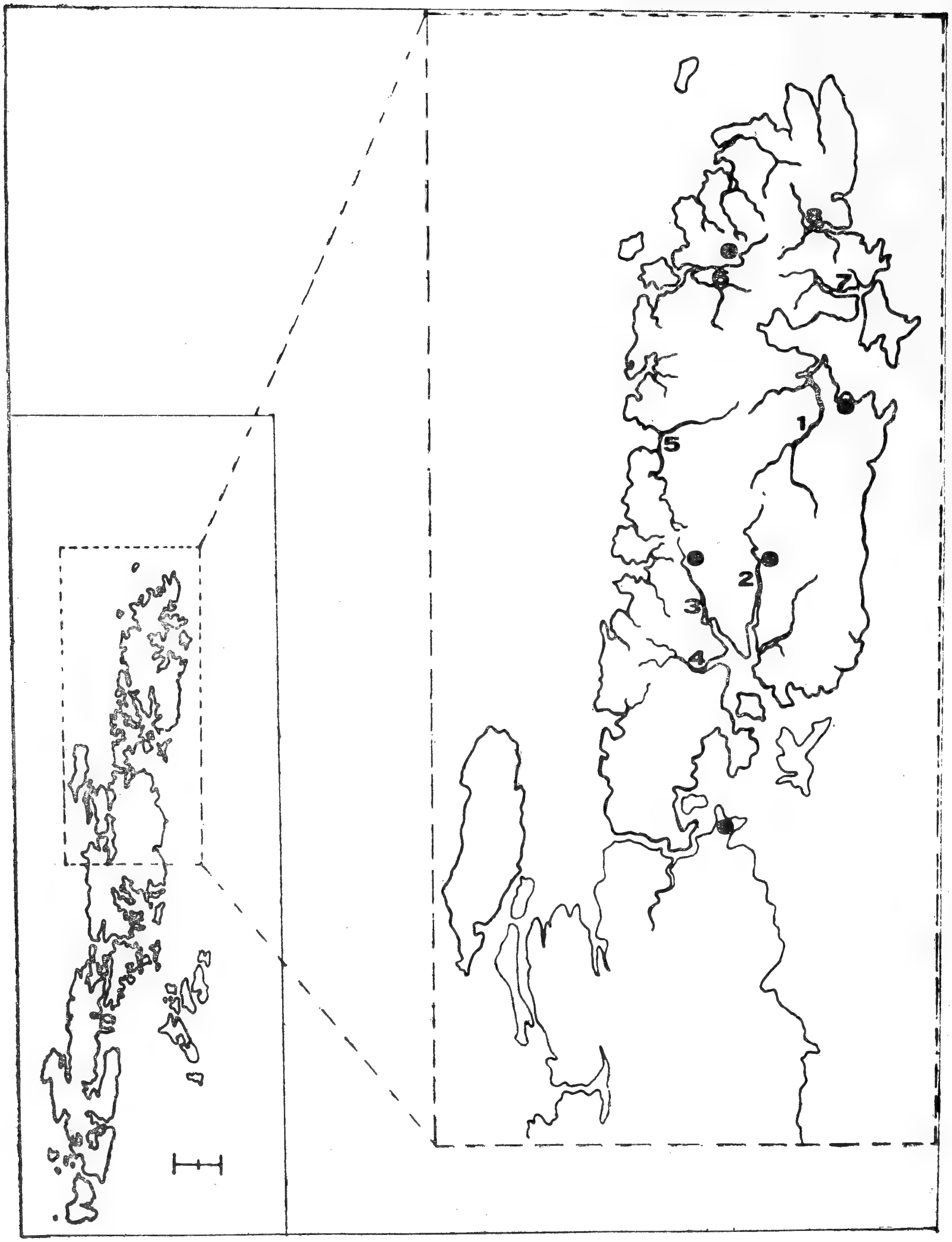


Fig. 2. Map of the Andamans showing details of North Andaman. Solid dots represent centres of field activity. Scale on small map represents 16 km. Large map not to scale. Numbers refer to rivers and creeks as detailed below:
1. Kalpang river, 2. Kalara Creek, 3. Parangara Creek, 4. Balmi Creek, 5. Creeks emptying into Casurina Bay, 6. Creeks South-West of Shyamnagar, 7. Creeks near Gandhinagar, 8. Creek emptying into Caddle Bay.

Andaman give a mean, based on confirmed nest data, of fiftyone eggs (range 42 to 67), remarkably similar to the data of Webb *et al.*

Nest materials in the present study were fresh leaves of standing canes eight to nine feet tall, fresh leaves of the much taller creeping cane, and dead evergreen tree leaves. This agrees with Smith (1931). Neill (1971) found tall green grass or herbaceous aquatic plants most commonly used in the Philippines, Indonesia and Papua. Kopstein (1929) noted that in Java the nests were constructed of man height grass and small branches. It would appear that the saltwater crocodile uses the available material. For instance, in North Andaman there is no herbaceous aquatic vegetation, and the single nest found in cultivated land was made of grass and miscellaneous shrubs.

In the present study no emaciated crocodiles were seen as reported by Deraniyagala. We believe that the nest-guarding female leaves the nest periodically for unknown periods of time. This fits in with frequent observations of tracks leading from the nests to the water and absence of female crocodiles from the wallows near the nest, a view which agrees with the data of Webb *et al.* (1977) but conflicts with the data of Deraniyagala (1939). Incidentally, the latter's observation that two nest-guarding individuals which he shot had empty stomaches is not convincing data that they do not feed during the incubation period as very many stomachs of crocodiles shot during the course of normal activities were found to be completely empty of food (Cott 1961).

Neill (1971) states that the female saltwater crocodile will guard the nest against man. We have no personal experience of this in Andamans, although occasional instances are known to us from elsewhere. We consider the trait unusual, nowadays, since such nest-guarding females are usually killed.

Human predation was found to be eleven times more serious than that of either the water monitor lizard or wild pigs (Table 2). These latter predators could have been expected to take a larger proportion of eggs in the absence of a such a high level of human predation. Human predators, as a result of deliberate hunting for eggs, get to the nest shortly after the eggs have been laid, before other predators chance upon the nest. The intensity of human predation on saltwater crocodile nests is in part a result of the belief in the medicinal properties of the eggs (believed to be a reliable cure for rheumatism and bronchitis) combined with the fact that the nesting season takes place with the onset of the South-West monsoon at a time when the villagers are going to the forest to collect cane and bamboo to fence in their fields against wild pig (*Sus andamanicus*) and cheetal (*Axis axis*). Cultivation has not yet started, and encouraged by the believed medicinal values of the eggs, they have ample time to search out the nests.

The very high level of predation, despite nest-guarding by the female, requires elaboration. Firstly, taking the case of the two main non-human predators, the female crocodile, if present at the nest, will not hesitate to attack. However, during an incubation period extending over about two months, it is not possible for the female to remain alert at all times. Even when the female is present at one of the wallows it may be possible for a predator to approach the nest undetected from the other side. An instance of this was observed when visiting a nest, the eggs of which had been eaten by the water monitor. The female crocodile was present in one of the wallows at the time of the visit and it

could be seen that the nest had been opened from the opposite side through a neat hole (Plate V) and the entire clutch consumed. As mentioned in Results the mother crocodile does not remain at the nest throughout the entire incubation period. Should the predator arrive at the nest during one of the absences of the female predation is, of course, simple. The nest guarding behaviour of the female crocodile is an aspect of the nesting biology which deserves quantitative study in the field.

Turning to human predation, there has been active selection against females which will guard the nest in the face of a human intruder. Since, such females are easily killed they do not survive to pass on this trait to their offspring (it should be noted that crocodile hunters elsewhere in the world, who may not be interested in the eggs, often shoot nest-guarding female due to the ease with which they can (could) be shot. Nowadays it is unusual, therefore, for a female to attack humans at the nest and it would seem that the present predation pattern on adults, as well as eggs, would favour poor mothers who desert the nest at the first sight of a human intruder! To this should be added the fact that hunting pressure has reduced the average age, and, therefore, average size of nest guarding females. Not only are present-day, nest-guarding females, smaller and therefore, less able physically to protect the nest against predators but they are new or relatively new nesters and, therefore, inexperienced.

The small size of most of the observed females reinforces the concern for the future of this population, since it indicates that they have only recently recruited to the breeding population, and that hunting pressure on nesting females is severe.

Exact information about the female breeding population size can be gathered from precise knowledge of the number of nests. In the present study thirty nests in which eggs have been laid were located, and an additional nest was located which had been constructed by a female which did not lay eggs in it. This phenomenon is discussed by Webb *et al.* This female might have laid subsequently elsewhere. The nest survey was carried out exhaustively. It is unlikely that nests were missed except, perhaps, in the most remote areas. If it is assumed that a further five to six nests were laid and missed, this gives a breeding population of thirtysix females for North Andaman, considered to be the best remaining area in the Andamans for the saltwater crocodile. Assuming the expected sex ratio of about 2.5 females per male the breeding male population would be approximately 15. Due to a probably higher incidence of killing nesting females the male population may be somewhat higher.

There is a need to strengthen the Wild Life Wing of the Andamans Forest Department so that it can offer more effective protection in the field to such an endangered—and fully protected—member of the Indian fauna. A Union Territory such as Andaman and Nicobars should set an example to other States. The problem of the conservation of the saltwater crocodile—on an all India basis—is taken up in a later paper.

Acknowledgements

The study was carried out as a part of Government of India Project on Crocodile Breeding and Management. We gratefully acknowledge the support of our respective organisations, the Forest Department of Andhra Pradesh and the Food and Agriculture Organisation of the United Nations. We are also indebted to Andaman and Nicobar Forest Department for their co-operation and field assistance.

References

Blasco, F. (1977): Outlines of Ecology, Botany and Forestry of the Mangals of the Indian Subcontinent. *In* Chapman, V. J. (1977), (Editor) Ecosystems of the World. Elsevier Amsterdam.

Cott, H. B. (1961): Scientific Results of an Enquiry into the Ecology and Economic Status of the Nile Crocodile (*Crocodylus niloticus*) in Uganda and Northern Rhodesia. *Trans. zool. Soc. Lond. 29*: 211-337.

Deraniyagala, P. E. P. (1939): The Tetrapod Reptiles of Ceylon Vol. I. Testudinates and Crocodilians. Colombo Museum, Ceylon.

Lal, P. (1976): Andaman Islands, a Regional Geography, Arthropological Survey of India, Government of India. Calcutta.

Kopstein, F. (1929): Herpetolozische notizen II Onlogische Bcobachtunen am West-Jaranischen Reptilien. *Treubia 11*: 301-307.

Neill, W. T. (1971): The Last of the Ruling Reptiles, Alligators, crocodiles and their Kin. Columbia University Press, New York.

Smith, M. A. (1931): The Fauna of British India including Ceylon and Burma. Reptilia Vol. I. Loricata, Testudines. Taylor and Francis, London.

Webb, G. J. W., Messel, H., and Magnusson, W. (1977): The nesting of *Crocodylus porosus* in Arnhem Land, Northern Australia. *Copeia, 1977* (2): 238-50.

Whitaker, R. and Whitaker, Z. (1978): Preliminary Survey of the Saltwater Crocodile (*Crocodylus porosus*) in the Andaman Island. *J. Bombay nat. Hist. Soc., 75* (1): 43-49.

NEW DESCRIPTIONS

TAXONOMIC STUDIES ON SOME INDIAN EULOPHID PARASITES (HYMENOPTERA: CHALCIDOIDEA)[1]

M. YOUNUS KHAN AND S. ADAM SHAFFE[2]

(*With four text-figures*)

Additional generic characters of pronotum, subgenital plate and external female genitalia are proposed for the genera *Euplectrus* Westwood, *Scotolinx* Ashmead and *Syntomosphyrum* Foerster. One known species of *Euplectrus* (*E. gopimohani* Mani), one known species of *Scotolinx* (*S. quadristriata* Subba Rao and Ramamani) and two new species of *Syntomosphyrum* (*S. udaipurensis* sp. nov. and *S. anomalococci* sp. nov.) are described in detail. Key to species of *Syntomosphyrum* is also provided. Holotypes, paratypes and other material examined by the authors are deposited in Zoological Museum, Aligarh Muslim University, Aligarh, India.

Genus **Euplectrus** Westwood

Euplectrus Westwood, 1832, *Phil. Mag.* 3: 128.

Type-species: *Euplectrus maculiventris* Westwood = *Pteromalus bicolor* Swederus (Monobasic).

The genus *Euplectrus* was proposed by Westwood (1832) for the species *Euplectrus maculiventris* Westwood. The genera *Diplectron* Dahlbom and *Pachyscapha* Howard are generally considered as synonyms of *Euplectrus* Westwood by all recent workers. Recently, Kerrich (1974) synonymized the genus *Rekabia* Cameron with *Euplectrus* Westwood. The distinguishing characters of this genus have been given in detail by Nikol'skaya (1952) and Peck *et al.* (1964). Some new generic characters are suggested namely Pronotum with anterior margin deeply concave in middle, antero-lateral arms long and narrow, posterior margin convex (fig. 1 D); first valvifers triangular with basal and apical angles at different levels (fig. 1 K); third valvulae rudimentary, articulated with second valvifers (fig. 1 L); outer plates of ovipositor narrow at base, broadened at apex (fig. 1 M); subgenital plate of uniform width, anterior margin straight, posterior margin with a notch in middle (fig. 1 N).

Euplectrus gopimohani Mani (Fig. 1 A-N)

Euplectrus gopimohani Mani, 1941, *Indian J. Ent.*, 3: 33.

FEMALE (Redescribed in detail).

Head (fig. 1 A).—Dark with metallic reflections except clypeal region which is yellowish brown, triangular in facial view; frontovertex slightly more than twice as wide as long, width slightly more than half the total head width; ocelli white, arranged in obtuse triangle, lateral ocelli twice their own diameters from orbital margin and less than their own diameters from occipital margin; eyes dark brown and smooth; antennae inserted below lower level

[1] Accepted July 1977.

[2] Section of Entomology, Department of Zoology, Aligarh Muslim University, Aligarh, India.

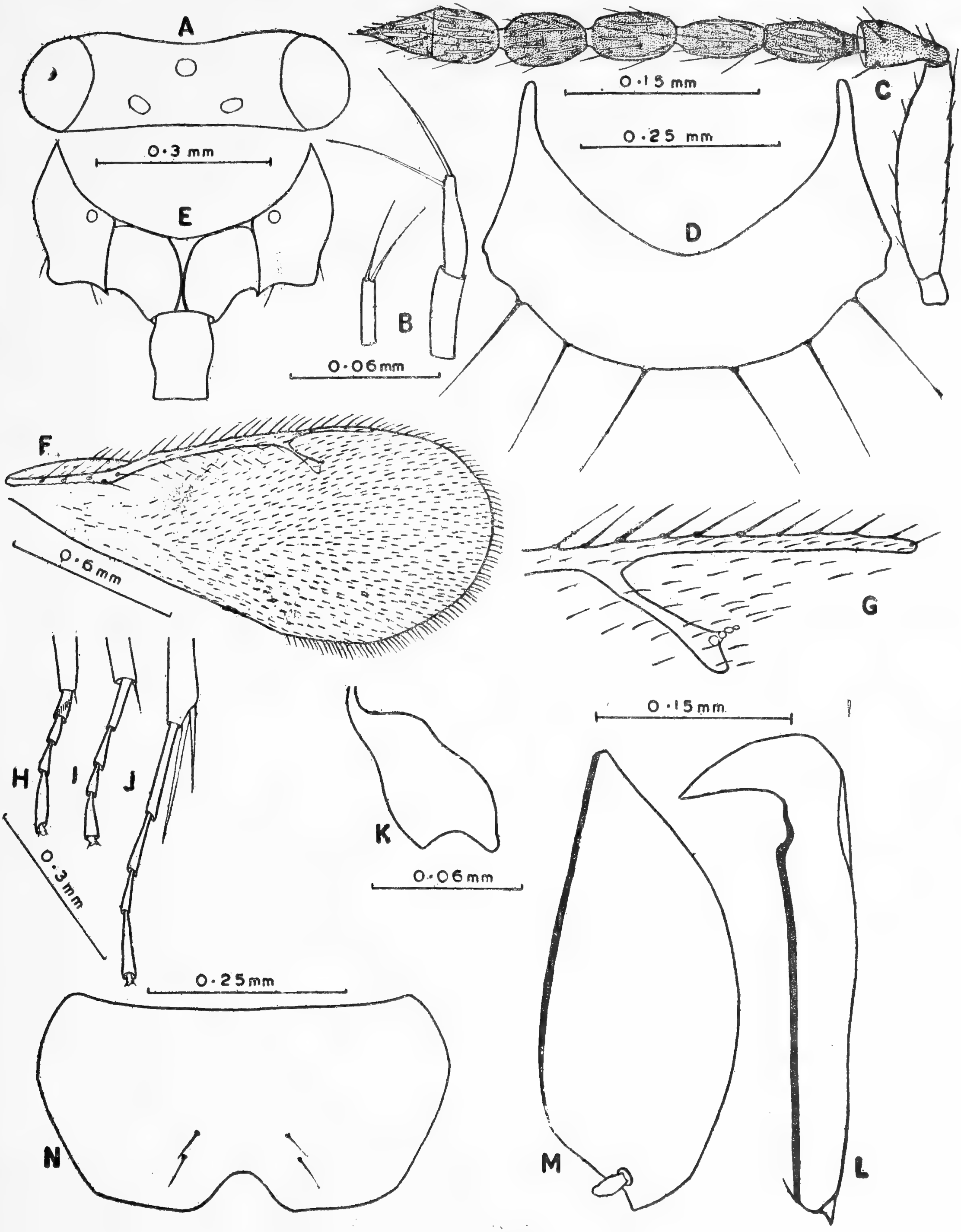


Fig. 1 A-N. *Euplectrus gopimohani* Mani, ♀: (A) Head in dorsal view; (B) Maxillary and labial palpi; (C) Antenna; (D) Pronotum; (E) Propodeum and petiole in dorsal view; (F) Fore wing; (G) Part of fore wing venation; (H) Part of fore leg; (I) Part of Middle leg; (J) Part of hind leg; (K) First valvifer; (L) Second valvifer and third valvula; (M) Outer plate of ovipositor; (N) Subgenital plate.

of eyes; prominence between antennal sockets less than one-third the width of frons between eyes; malar space longer than eye width; malar sutures distinct; maxillary and labial palpi 2 and 1-segmented respectively (fig. 1 B).

Antennae (fig. 1 C).—Brown except scape which is yellow, 8-segmented excluding two ring segments; scape cylindrical, slightly more than four times as long as wide (0.22:0.05 mm); pedicel slightly less than twice as long as wide, slightly longer than first funicle segment; funicle 4-segmented, first shortest and twice as long as wide; segments 2-4 subequal in length, gradually widened distad, each more than one and a half times as long as wide; club 2-segmented, two and a half times as long as wide (0.15:0.06 mm), shorter than preceding two funicle segments together.

Thorax.—Dark with metallic reflections and reticulately sculptured; pronotum with anterior margin deeply concave in middle, antero-lateral arms long and narrow, posterior margin much convex bearing 3 pairs of long setae (fig. 1 D); parapsidal furrows well developed; scutum wider than long; scutellum longer than wide; scutum, parapside and scutellum with 6, 4 and 4 setae respectively; axillae bare; propodeum with a median carina (fig. 1 E).

Fore wings (fig. 1 F).—Hyaline, slightly more than twice as long as wide (1.5:0.7 mm); costal cell shorter than marginal vein and with 5 long and 10 small setae; submarginal and marginal veins with 3 and 13 setae respectively; stigmal vein less than one-third the length of marginal vein and one-half the length of postmarginal vein (fig. 1 G); marginal fringe short, spaced by a distance equal to one-third their length.

Hind wings.—Hyaline, five times as long as wide; marginal fringe short, spaced by a distance equal to one-half their length.

Legs (fig. 1 H-J).—Honey yellow; tarsi 4-jointed; hind legs with two tibial spurs, longest tibial spur shorter than the length of basal two tarsal joints together (fig. 1 J).

Abdomen.—Dark except a broad patch on mid of dorsum which is yellow; petiole one and a half times as long as wide; ovipositor concealed, arising from apical one-third of abdominal venter; first valvifers triangular with basal and apical angles at different levels, basal margin concave (fig. 1 K); second valvifers of uniform width, third valvulae rudimentary, articulated with second valvifers (fig. 1 L); outer plates of ovipositor narrow at base, widened at apex (fig. 1 M); subgenital plate of uniform width, anterior margin straight, posterior margin with a wide notch in middle (fig. 1 N).

Female length: 1.86 mm.

Material examined.—1 ♀, INDIA: Uttar Pradesh, Aligarh, University Campus, ex Lepidopterous Larva, 10.x.1977 (*M. Younus Khan*).

Genus **Scotolinx** Ashmead

Scotolinx Ashmead, 1904, *Mem. Carnege. Mus.*, 1: 354.

Type-species: *Scotolinx gallicola* Ashmead.

The genus *Scotolinx* was proposed by Ashmead (1904) for the species *Scotolinx gallicola* Ashmead. The distinguishing characters of this genus have been given by Ashmead (1904). We suggest some new generic characters which are as follows: Pronotum of uniform width, anterior margin slightly concave in middle, posterior margin straight (fig. 2 E); first valvifers semicircular with basal and apical angles at different levels (fig. 2 H); third valvulae blunt, movably articulated with second valvifers (fig. 2 I); outer plates of ovipositor long, slightly shorter than second valvifers with a mid-longitudinal ridge (fig. 2 J); subgenital plate with anterior margin straight,

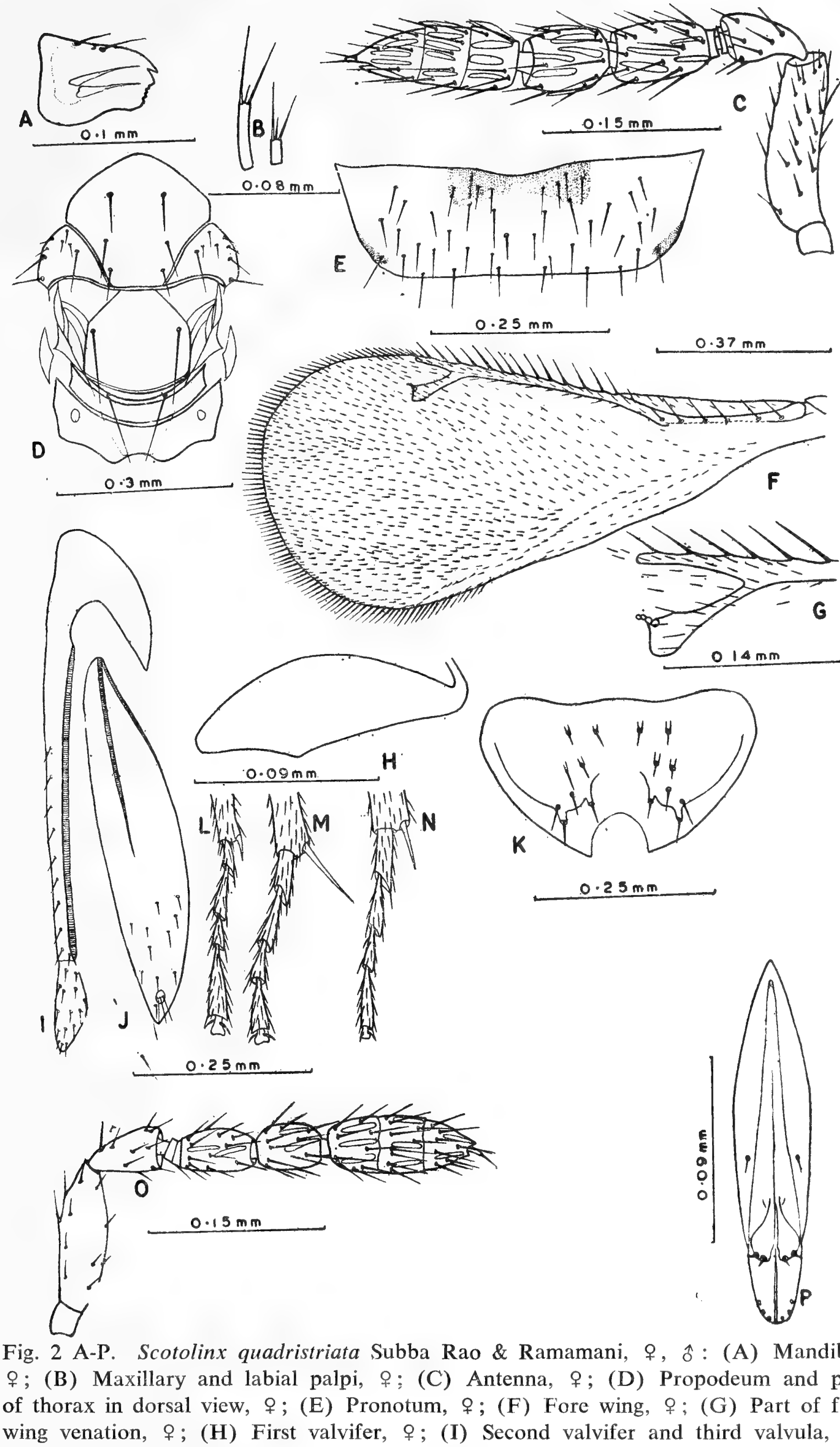


Fig. 2 A-P. *Scotolinx quadristriata* Subba Rao & Ramamani, ♀, ♂: (A) Mandible, ♀; (B) Maxillary and labial palpi, ♀; (C) Antenna, ♀; (D) Propodeum and part of thorax in dorsal view, ♀; (E) Pronotum, ♀; (F) Fore wing, ♀; (G) Part of fore wing venation, ♀; (H) First valvifer, ♀; (I) Second valvifer and third valvula, ♀; (J) Outer plate of ovipositor, ♀; (K) Subgenital plate, ♀; (L) Part of fore leg, ♀; (M) Part of middle leg, ♀; (N) Part of hind leg, ♀; (O) Antenna, ♂; (P) Genitalia, ♂.

posterior margin with a semicircular notch in middle, postero-lateral ridges present (fig. 2 K); male genitalia with gonobase shorter than aedeagus, digitus with two projections (fig. 2 P).

Scotolinx quadristriata Subba Rao and Ramamani (Fig. 2 A-P)

Scotolinx quadristriata Subba Rao and Ramamani, 1965, *Indian J. Ent.* 27: 412.

FEMALE

Head.—Orange yellow and setose, slightly wider than long in facial view (0.28:0.23 mm); frontovertex wider than long, width about one-half the total head width; ocelli red, arranged in obtuse triangle, lateral ocelli twice their own diameters from orbital margin and their own diameters from occipital margin; eyes red and smooth; malar sutures distinct; malar space longer than eye width; antennae inserted at lower level of eyes; mandibles bidentate with one acute tooth and a broad truncation having serrations (fig. 2 A); maxillary and labial palpi each l-segmented (fig. 2 B).

Antennae (fig. 2 C).—Yellowish brown, 7-segmented excluding 2 ring segments; scape flattened, slightly more than three times as long as wide, about as long as club; pedicel one and a half times as long as wide, slightly shorter than first funicle segment; funicle 2-segmented, first funicle segment slightly more than one and a half times as long as wide, longer than second; club 3-segmented, two and a half times as long as wide, slightly shorter than funicle.

Thorax (fig. 2 D).—Orange yellow pronotum of uniform width, anterior margin straight, slightly concave in middle, antero-lateral angles acute, posterior margin straight bearing 4 pairs of setae (fig. 2 E); parapsidal furrows complete; scutum and scutellum with 6 and 4 setae respectively; mesopostphragma well developed, not reaching beyond the propodeum.

Fore wings (fig. 2 F).—Hyaline slightly more than twice as long as wide (1.26:0.58 mm); costal cell as long as marginal vein and with 11 small setae; submarginal vein with 5 setae; marginal vein with 12 setae; postmarginal slightly shorter than stigmal and one-fourth the length of marginal vein (fig. 2 G); marginal fringe spaced by a distance equal to one-fourth their length.

Hind wings.—Hyaline, five and a half times as long as wide; marginal fringe one-third the wing width, spaced by distance equal to one-fifth their length.

Legs (fig. 2 L-N).—Yellow; middle tibial spur longer than basitarsus (fig. 2 M).

Abdomen.—Yellow, except dorsum with four transverse brown bands, silghtly longer than thorax; ovipositor slightly exserted, arising from base of abdominal venter; first valvifers semicircular, with basal and apical angles at different levels (fig. 2 H); anterior margin of basal part of second valvifers much curved, U-shaped; third valvulae two and a half times as long as wide, about one-fifth the length of second valvifers (fig. 2 I); outer plates of ovipositor long, widened in middle with mid-longitudinal ridge, shorter than second valvifers (fig. 2 J); subgenital plate with anterior margin straight, posterior margin with a semicircular notch in middle, postero-lateral ridges present (fig. 2 K).

Female length: 1.38 mm.

MALE

Resembles female except in the following characters:

Male genitalia with gonobase shorter than aedeagus, digitus short, each with two pro-

jections (fig. 2 P).

Male length: 0.98 mm.

Material examined: 2 ♀, 1 ♂, INDIA: Rajasthan, Udaipur, ex leaf mining Lepidoptera on *Citrus* sp., 1.x.1975 (*M. Younus Khan*).

Genus **Syntomosphyrum** Foerster

Syntomosphyrum Foerster, 1878, *Verhandl. Naturhist. Ver. Preuss. Rheinl. u. Westfalens*, 35: 60.

Type-species: *Syntomosphyrum fulvipes* Foerster (Monobasic).

The genus *Syntomosphyrum* was proposed by Foerster (1878) for the species *S. fulvipes* Foerster. Muesebeck *et. al.* (1951) considered the genus *Tetrastichopsis* Girault to be a synonym of *Syntomosphyrum* Foerster. Recently, *Syntomosphyrum* Foerster was synonymized with *Aprostocetus* Westwood by Graham (1961) and with *Tetrastichus* Haliday by Domenichini (1965). However, Waterston (1915 a & b), Ferrière (1933, 1940). Muesebeck *et al.* (1951), Kurian (1954), Burks (1952, 1967), Risbec (1957), Peck (1963) and Peck *et al.* (1964) recognized *Syntomosphyrum* as a valid genus. They separated it from its closely allied genera by the absence of longitudinal grooves on scutum and scutellum. We have followed earlier workers in treating *Syntomosphyrum* as a valid genus. This view gets support from Kerrich's (1969) separation of *Platocharis* Kerrich and *Schizocharis* Kerrich on the basis of the presence or absence of scutellar grooves. Some new generic characters are suggested namely Pronotum with anterior margin deeply concave, posterior margin straight or slightly curved (fig. 3 F; fig. 4 D); third valvulae movably articulated with second valvifers (fig. 3 I; fig. 4 H); posterior margin of subgenital plate with a notch in middle (fig. 3 K; fig. 4 J); male genitalia with gonobase longer than aedeagus, digitus short, each with single projection (fig. 3 N).

KEY TO SPECIES OF *Syntomosphyrum* FOERSTER, BASED ON FEMALES

1. Funicle segments subquadrate or longer than wide.......................................2
— Funicle segments transverse; first funicle segment with two sensoria; bristle to spur of club as long as or longer than the last club joint...... ....*S. indicum* Silvestri
2. Pedicel longer than first funicle segment......3
— Pedicel as long as or shorter than first funicle segment......................................4
3. Abdomen shorter than head and thorax together; antennae with 2 ring segments; vertex smooth; body aeneous black......*S. javanicum* Ferriere
— Abdomen as long as head and thorax together; antennae with 3 ring segments; vertex finely punctate; body orange yellow.................. ....*S. obscuriceps* Ferriere
4. Pedicel shorter than first funicle segment; first funicle segment more than one and a half times as long as wide; thorax brown or yellow, non-metallic; submarginal vein with 3 or 4 setae... 5
— Pedicel as long as first funicle segment; first funicle segment as long as wide; thorax dark brown; submarginal vein with 2 setae......... ....*S. taprobanes* Waterston
5. Thorax brown; scutum with 16 longitudinal ridges anteriorly and with a row of 4 setae near each parapsidal furrow (fig. 3 E); first funicle segment less than twice as long as wide, second and third each slightly longer than wide; club much longer than preceding two funicle segments together; submarginal vein with 3 setae; first valvifers with basal and apical angles at different levels (fig. 3 H).................... ....*S. udaipurensis* sp. nov.
— Thorax yellow; scutum with 4 or 5 longitudinal ridges anteriorly and with 8 setae irregularly arranged near each parapsidal furrow (fig. 4 C); first funicle segment more than twice as long as wide, second and third each twice as long as wide; club as long as preceding two funicle segments together; submarginal vein with 4 setae; first valvifers almost semicircular with basal and

apical angles in one plane (fig. 4 G) .... *S. anomalococci* sp. nov.

Syntomosphyrum undaipurensis sp. nov.
(Fig. 3 A-N)

FEMALE

Head (fig. 3 A).—Brown, wider than long in facial view; frontovertex width more than one-half the total head width; ocelli yellowish, arranged in obtuse triangle, lateral ocelli slightly more than their own diameters from orbital and less than their own diameters from occipital margins; eyes red and smooth; malar space longer than eye width; malar sutures distinct; antennae inserted above lower level of eyes; prominence between antennal sockets about one-fourth the width of frons between eyes; mandibles tridentate with apical tooth long and acute, mesal small and acute, lower rudimentary (fig. 3 B); maxillary and labial palpi each 1-segmented (fig. 3 D).

Antennae (fig. 3 C).—Brownish, except scape and apical half of pedicel which are yellow; 8-segmented excluding 2 ring segments; scape cylindrical, slightly more than three times as long as wide (0.10:0.03 mm); pedicel one and a half times as long as wide, shorter than first funicle segment; funicle 3-segmented; segments 1-3 gradually decreasing in length distad; first funicle segment longest, more than one and a half times as long as wide, second and third slightly longer than wide; club 3-segmented, much longer than preceding two funicle segments together.

Thorax (fig. 3 E).—Brown; pronotum broad, antero-lateral angles acute, posterior margin straight, lateral margin of each side with a small protuberance, posterior submarginal ridge absent (fig. 3 F); scutum slightly wider than long with 16 longitudinal ridges anteriorly and a row of 4 setae near each parapsidal furrow; each parapside with single seta; scutellum wider than long and with two pairs of setae; scutum and scutellum without longitudinal grooves; propodeum with a median carina diverging backwards.

Fore wings (fig. 3 G).—Hyaline, slightly more than twice as long as wide (0.85:0.4 mm); costal cell long and narrow, slightly shorter than marginal vein and with 8 small setae; submarginal and marginal veins with 3 and 11 setae respectively; postmarginal vein rudimentary; marginal fringe short, spaced by a distance equal to one-fourth their length.

Hind wings.—Hyaline, four times as long as wide; marginal fringe spaced by a distance equal to one-fourth their length.

Legs.—Yellow; tarsi 4-jointed; mid tibial spur shorter than basitarsus.

Abdomen.—Dark brown except base which is yellow, as long as head and thorax together; ovipositor slightly exserted, arising from near base of abdominal venter; first valvifers semicircular with basal and apical angles at different levels (fig. 3 H); third valvulae five times as long as wide, slightly less than one-half the length of second valvifers (fig. 3 I); outer plates of ovipositor long and of uniform width (fig. 3 J); subgenital plate with anterior margin slightly concave, posterior margin semicircular with a notch in middle (fig. 3 K).

Female length: 1.07 mm.

MALE

Resembles female except in the following characters:

Body yellowish brown; antennae (fig. 3 M) 9-segmented; scape slightly flattened, two and a half times as long as wide; pedicel slightly longer than wide, longer than first funicle segment; funicle 4-segmented, each segment with a whorl of long hairs; first funicle segment

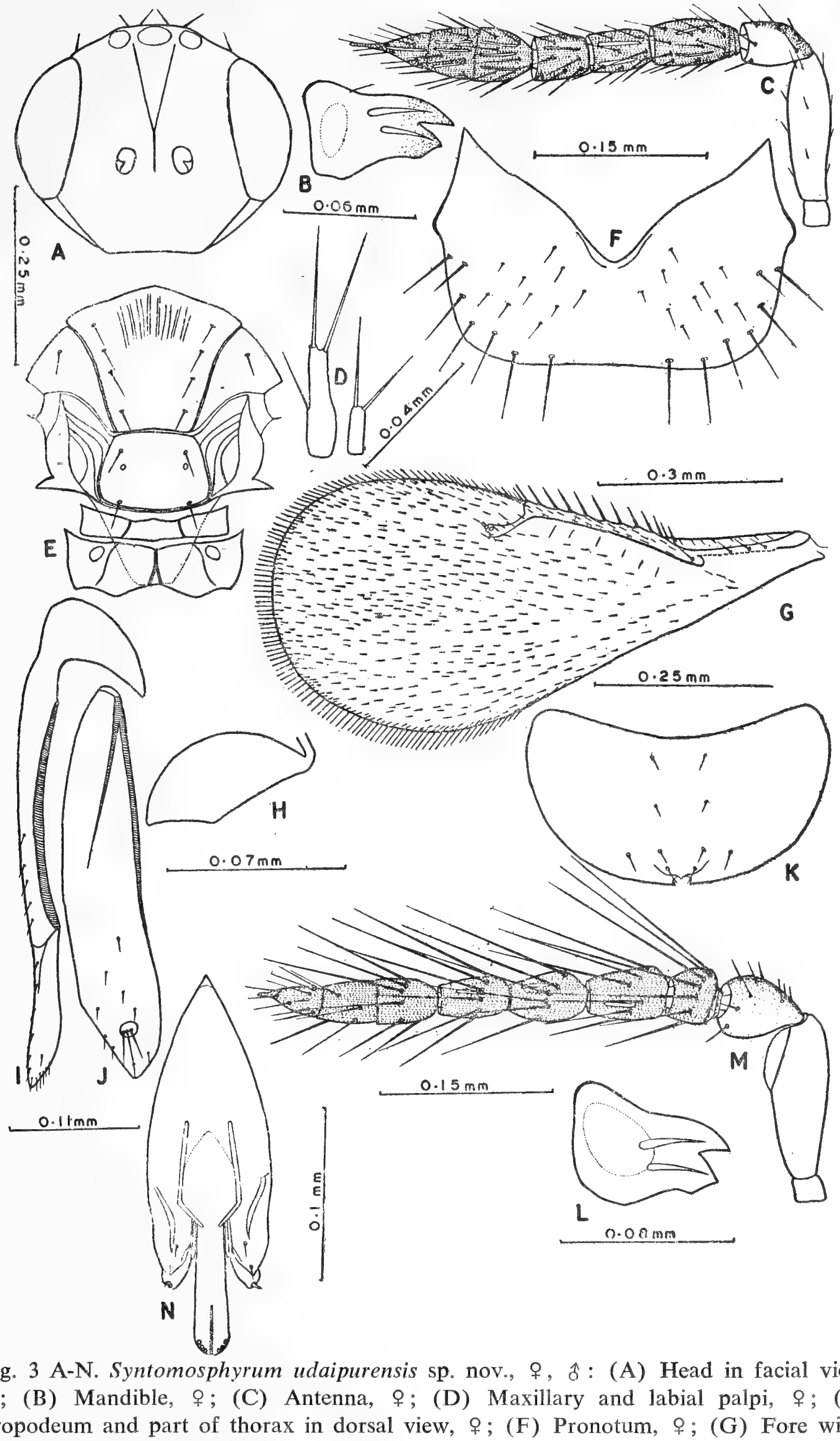


Fig. 3 A-N. *Syntomosphyrum udaipurensis* sp. nov., ♀, ♂: (A) Head in facial view, ♀; (B) Mandible, ♀; (C) Antenna, ♀; (D) Maxillary and labial palpi, ♀; (E) Propodeum and part of thorax in dorsal view, ♀; (F) Pronotum, ♀; (G) Fore wing, ♀; (H) First valvifer, ♀; (I) Second valvifer and third valvula, ♀; (J) Outer plate of ovipositor, ♀; (K) Subgenital plate, ♀; (L) Mandible, ♂; (M) Antenna, ♂; (N) Genitalia, ♂.

slightly wider than long, one-half the length of second segment, segments 2-4 subequal in length, each distinctly longer than wide; club four times as long as wide; male genitalia with gonobase two and a half times as long as wide, longer than aedeagus, anterior margin of basal part much acute, digitus with a small projection, aedeagal shaft long (fig. 3 N).

Male length: 0.96 mm.

Holotype ♀. INDIA: Orissa, Bhubaneswar, ex eggs of Fulgorid on *Ficus* sp., 4.ix.1975 (*M. Younus Khan*).

Paratypes. 4 ♀, 3 ♂ (same data as holotype); 10 ♀, Rajasthan, Udaipur, ex eggs of *Pyrilla* sp. on *Saccharum officinarum* Linn., 10.viii.1977 (*M. Younus Khan*).

Syntomosphyrum anomalococci sp. nov.
(Fig. 4 A-J)

FEMALE

Head.—Yellowish except ocellar and postoccipital regions which are dark drown, slightly wider than long in facial view; frontovertex width slightly less than one-half the total head width; ocelli white, arranged in equilateral triangle; lateral ocelli less than their own diameters from orbital and occipital margins separately; eyes red and smooth; antennae inserted above lower level of eyes; prominence between antennal sockets one-third the width of frons between eyes; malar sutures distinct; malar space shorter than eye width; mandibles tridentate with apical tooth long and acute (fig. 4 A); maxillary and labial palpi each 1-segmented.

Antennae (fig. 4 B).—Yellowish brown except scape which is yellow, 8-segmented excluding 2 ring segments; scape slightly flattened, slightly more than two and a half times as long as wide (0.13:0.05 mm); pedicel one and a half times as long as wide, shorter than first funicle segment; funicle 3-segmented, segments 1-3 gradually decreasing in length distad; first funicle segment slightly more than twice as long as wide, second and third each twice as long as wide; club 3-segmented, slightly less than four times as long as wide, as long as preceding two funicle segments together.

Thorax (fig. 4 C).—Yellow; pronotum broad with an infuscated patch in middle, antero-lateral angles acute, lateral margin of each side with small protuberance, posterior margin straight, posterior submarginal ridge absent (fig. 4 D); scutum slightly longer than wide, bearing 5 longitudinal ridges anteriorly and 8 irregularly arranged setae near each parapsidal furrow; each parapside with 7 setae; scutum and scutellum without longitudinal grooves; scutellum with 2 pairs of setae; propodeum with a median carina diverging backwards.

Fore wings (fig. 4 E).—Hyaline, about twice as long as wide; costal cell shorter than marginal vein; submarginal and marginal veins with 4 and 11 setae respectively (fig. 3 F); marginal fringe short, spaced by distance equal to one-third their length.

Hind wings.—More than four times as long as wide; marginal fringe spaced by a distance equal to one-third their length.

Legs.—Yellowish; mid tibial spur shorter than basitarsus.

Abdomen.—Yellow except dorsum with transverse brown bands, longer than thorax; ovipositor slightly exserted, arising from near base of abdominal venter; first valvifers almost semicircular with basal and apical angles in one plane (fig. 4 G); third valvulae long, six times as long as wide, less than one-half the length of second valvifers (fig. 4 H); outer plates of ovipositor long and of uniform width (fig. 4 I); subgenital plate of uniform width,

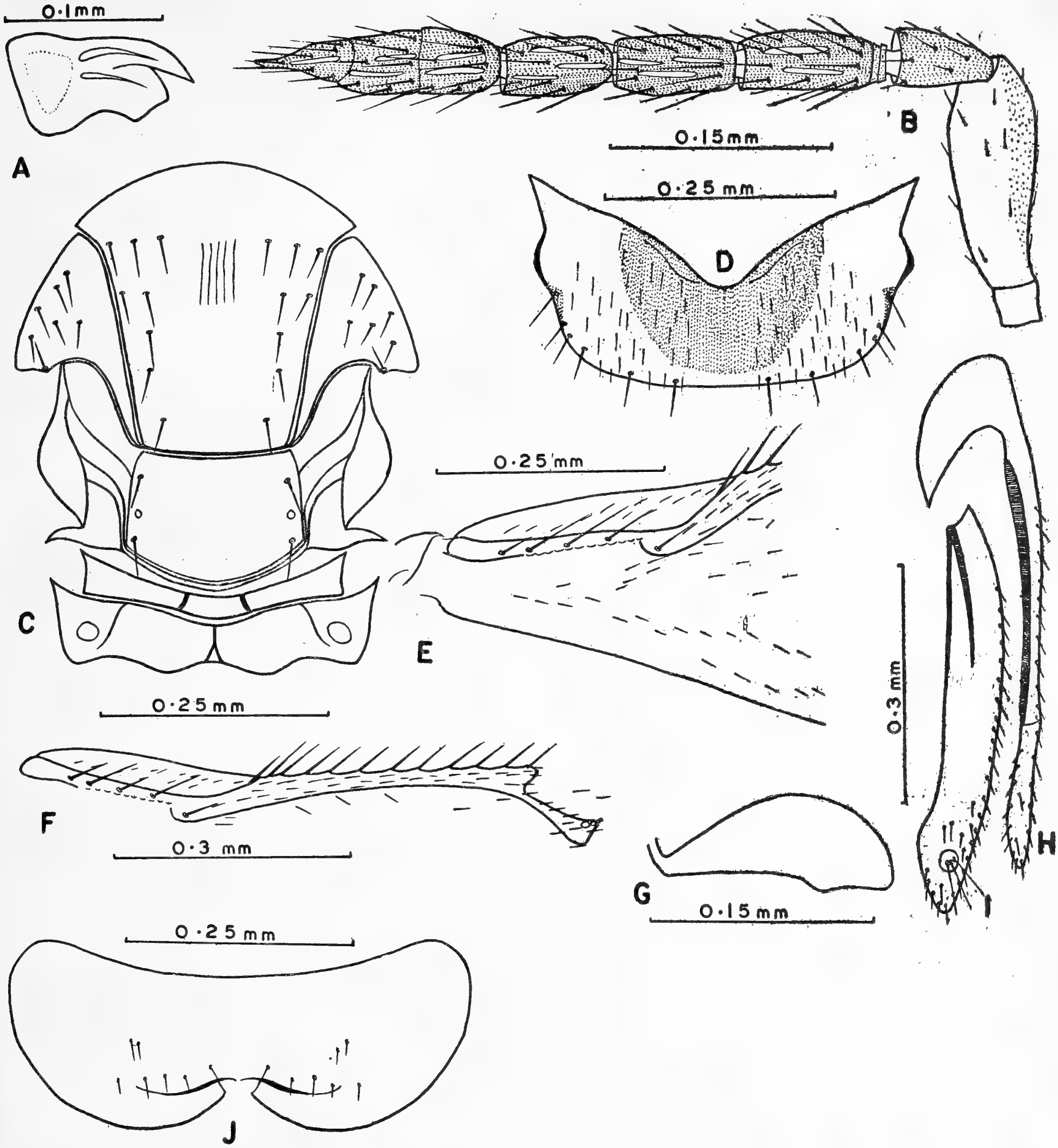


Fig. 4 A-J. *Syntomosphyrum anomalococci* sp. nov., ♀: (A) Mandible; (B) Antenna; (C) Propodeum and part of thorax in dorsal view; (D) Pronotum; (E) Basal part of fore wing; (F) Fore wing venation; (G) First valvifer; (H) Second valvifer and third valvula; (I) Outer plate of ovipositor; (J) Subgenital plate.

anterior margin slightly concave, posterior margin semicircular with a notch in middle (fig. 4 J).

Female length: 1.4 mm.

Holotype ♀. INDIA: Tamil Nadu, Vellore, ex *Anomalococcus cremastogastri* Green on *Acacia* sp., 4.i.1976 (*M. Younus Khan*).

Paratypes 15 ♀ (same data as holotype).

ACKNOWLEDGEMENTS

We are deeply indebted to Prof. S. Mashhood Alam, Head, Department of Zoology, for providing research facilities. Thanks are also due to Prof. Nawab H. Khan for encouragement.

REFERENCES

ASHMEAD, W. H. (1904): Classification of the chalcid-flies or the superfamily Chalcidoidea, with descriptions of new species in the Carnegie Museum, collected in south America by Herbert H. Smith. *Mem. Carneg. Mus. 1*: 225-555.

BURKS, B. D. (1952): The north American species of *Syntomosphyrum* (Hymenoptera: Chalcidoidea). *Proc. ent. Soc. Wash. 54*: 258-264.

——————— (1967): Superfamily Chalcidoidea. In K. V. Krombein & B. D. Burks (*Eds.*) Hymenoptera of America north of Mexico, synoptic catalog. Second supplement. Washington, D.C., USGPO. (USDA Agriculture Monograph no. 2), pp. 213-282.

DOMENICHINI, G. (1965): I. Tetrastichini (Hymenoptera: Eulophidae) paleartici ed i loro ospiti. *Boll. Zool. Agr. Bachic.* (*Ser.* 2), *6*: 61-205.

FERRIERE, C. (1933): Chalcidoid and Proctotrupoid parasites of pests of the coconut palm. *Stylops 2*: 86-108.

——————— (1940): On some parasites and hyperparasites of *Artona catoxantha* Hamps. *Bull. ent. Res. 31*: 131-139.

FOERSTER, A. (1878): Kleine Monographian parasitischer Hymenopteren. *Verh. naturh. Ver. Preuss. Rheinl. 35*: 42-82.

GRAHAM, M. W. R. DE V. (1961): The genus *Aprostocetus* Westwood, sensu (Hymenoptera: Eulophidae); notes on the synonymy of European species. *Entomologist's mon. Mag. 97*: 34-64.

KERRICH, G. J. (1969): Systematic studies on Eulophid parasites (Hym., Chalcidoidea), mostly of coffee leaf-miners in Africa. *Bull. ent. Res. 59*: 195-228.

——————— (1974): Systematic studies on Eulophidae of economic significance (Hymenoptera: Chalcidoidea). *Bull. ent. Res. 63*: 629-639.

KURIAN, C. (1954): Descriptions of some new chalcid parasites (Parasitic Hymenoptera) from India. *Agra Univ. J. Res.* (*Sci.*) *3*: 119-134.

MANI, M. S. (1941): Studies on Indian parasitic Hymenoptera. I. *Indian J. Ent. 3*: 25-36.

MUESEBECK, C. F. W., KROMBEIN, K. V. & TOWNES, H. K. (1951): Hymenoptera of America north of Mexico, (Synoptic catalog.). *U.S. Dep. Agr. Monogr. 2*: 1420 pp.

NIKOL'SKAYA, M. N. (1952): The chalcid fauna of the USSR (Chalcidoidea). *Opred. Faun. Zool. Inst. Akad. Nauk SSSR 44*: 575 pp.

PECK, O. (1963): A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). *Canad. Ent.* (*Suppl.*). *30*: 1092 pp.

——————— BOUCEK, Z. & HOFFER, A. (1964): Keys to the Chalcidoidea of Czechoslovakia (Insecta: Hymenoptera). *Mem. ent. Soc. Canad. 34*: 120 pp.

RISBEC, J. (1957): Contributions a l étude de la faune entomologique du Ruanda-urundi (Mission P. Basilewsky 1953). Hymenoptera. CXXIII. Chalcidoidea: Eulophidae, Pteromalidae, Eurytomidae, Torymidae, Perilampidae, Encyrtidae et Eupelmidae. *Annls. Mus. r. Congo belge Sér.* 8 vo (*Zool.*). *58*: 148-231.

SUBBA RAO, B. R. & RAMAMANI, S. (1965): Biology of *Cirrospiloideus phyllocnistoides* (Narayanan) and description of a new species *Scotolinx quadristriata* (Hymenoptera: Eulophidae) as parasites of *Phyllocnistis citrella* Stainton. *Indian J. Ent. 27*: 408-413.

——————— (1915a): New species of Chalcidoidea from Ceylon. *Bull. ent. Res. 5*: 325-342.

——————— (1915b): Notes of African Chalcidoidea-II. *Bull. ent. Res. 5*: 343-372.

WESTWOOD, J. O. (1832): Descriptions of several new British forms amongst the parasitic Hymenopterous insects. *Lond. Edimb. Dubl. Phil. Mag. 3*: 127-129.

INDIAN SPECIES OF THE GENUS *TRICHAPORUS* FOERSTER (HYMENOPTERA: APHELINIDAE)[1]

M. NAYYAR AZIM AND S. ADAM SHAFEE[2]

(*With eleven text-figures*)

The genus *Trichaporus* Foerster is recorded for the first time from India. Among the three species collected two have been described as new to science and one species *T. partenopeus* (Masi) has been reported for the first time. A key to the three Indian species of *Trichaporus* Foerster is given. The specimens have been deposited in the Zoological museum, Aligarh Muslim University, Aligarh, India.

Genus *Trichaporus* Foerster

Trichaporus Foerster, 1856, *Hym. Stud.* 2:84.
Type-species: *Encarsia partenopea* Masi. Designated by Nikol'skaya & Yasnosh, 1966, *Opred. Faune. SSSR.* 91:264.

The distinguishing characters of the genus *Trichaporus* Foerster have been given by Dozier (1933), Nikol'skaya (1952), Peck *et al.* (1964) and Nikol'skaya and Yasnosh (1966). This is the first report of the genus from India.

KEY TO THE INDIAN SPECIES OF *Trichaporus* FOERSTER, BASED ON FEMALES

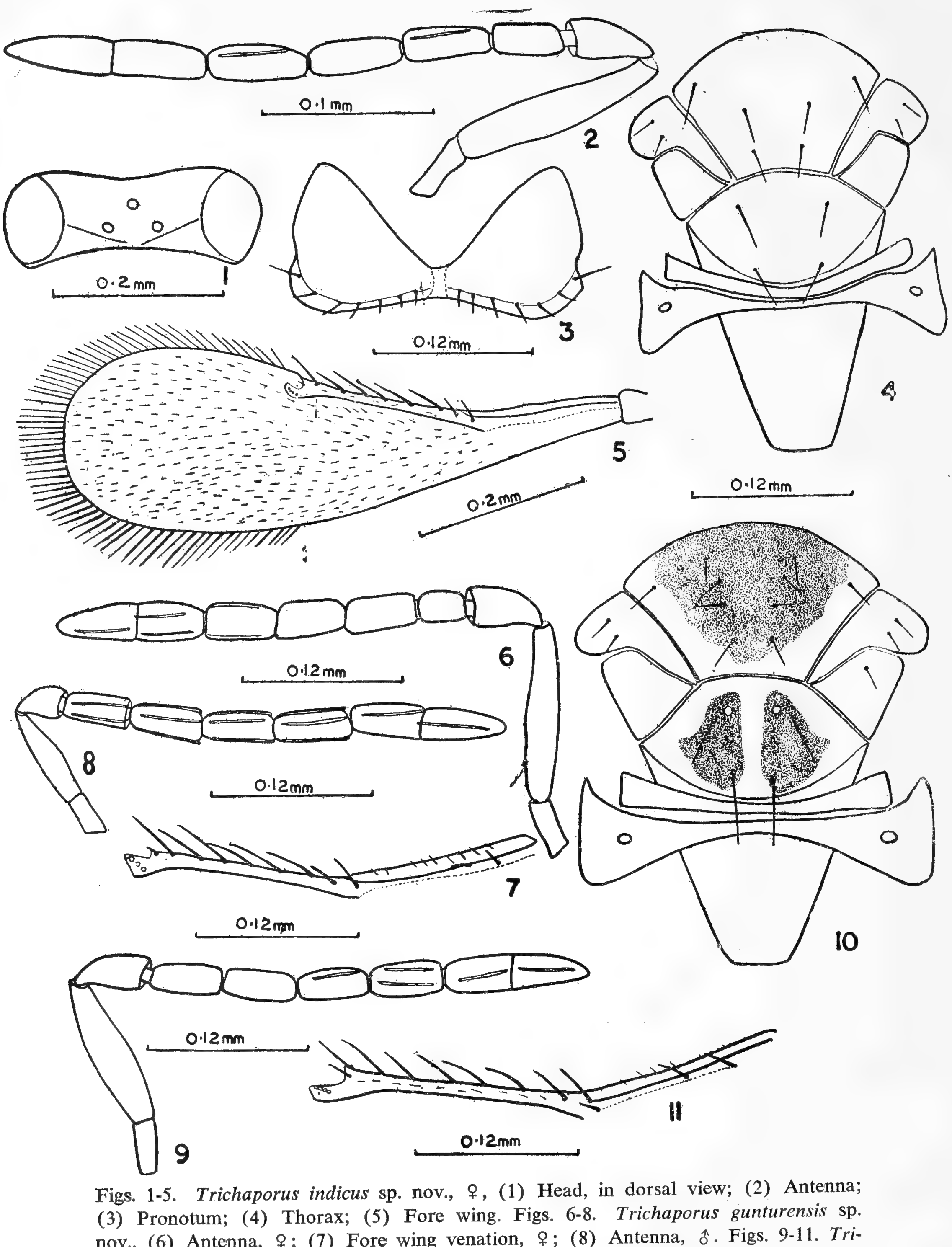
1. Thorax completely yellowish brown (Fig. 4); scape longer than basal two funicle segments together, first funicle segment shorter than second (Figs. 2, 6) 2
— Thorax yellowish brown except one large patch on scutum and two small patches on scutellum which are dark (Fig. 10; Nikol'skaya & Yasnosh, 1966, Fig. 468); scape as long as basal two funicle segments together, first funicle segment as long as second (Fig. 9; Nikol'skaya & Yasnosh, 1966, Fig. 469); funicle segments 1-4 subequal in length; third valvulae short .... *T. partenopeus* (Masi)
2. Coxae yellow; first funicle segment twice as long as wide; funicle segments 2-4 gradually increasing in length distad, each more than two and a half times as long as wide; club five times as long as wide; scutum with three pairs of setae .... *T. indicus* sp. nov.
— Coxae dark; first funicle segment one and a half times as long as wide; funicle segments 2-4 subequal, each about twice as long as wide; club four times as long as wide; scutum with four pairs of setae .... *T. gunturensis* sp. nov.

Trichaporus indicus sp. nov. (Figs. 1-5)

FEMALE: Head (Fig. 1) yellowish, wider than long in facial view (0.26:0.2 mm); frontovertex two times wider than long; ocelli red, arranged in obtuse triangle, basal ocellus separated by three times its diameter from eye rim and less than twice its diameter from occipital margin; prominence between antennal sockets one-fifth the width of frontovertex (0.03:0.15 mm); malar space slightly shorter than longitudinal diameter of eye (0.08:0.11 mm); eyes bare; mandibles tridentate; maxillary palpi 2-segmented, labial palpi unisegmented. Antennae (Fig. 2) yellowish; scape cylindrical, five times longer than wide, longer than basal two funicle segments together; pedicel twice as long as wide, distinctly longer than first funicle segment; first funicle segment shortest, about twice as long as wide; funicle segments 2-4 gradually lengthened distad, each more than $2\frac{1}{2}$ times longer than wide; club 2-segmented, five times longer than wide, slightly longer than preceding two funicle segments combined. Thorax yellowish

[1] Accepted May 1978.

[2] Section of Entomology, Department of Zoology, Aligarh Muslim University, Aligarh, India.



Figs. 1-5. *Trichaporus indicus* sp. nov., ♀, (1) Head, in dorsal view; (2) Antenna; (3) Pronotum; (4) Thorax; (5) Fore wing. Figs. 6-8. *Trichaporus gunturensis* sp. nov., (6) Antenna, ♀; (7) Fore wing venation, ♀; (8) Antenna, ♂. Figs. 9-11. *Trichaporus partenopeus* (Masi), ♀, (9) Antenna; (10) Thorax; (11) Fore wing venation.

brown; pronotum (Fig. 3) very narrow in middle, much expanded on sides, anterior margin deeply and acutely notched in middle; mesoscutum and scutellum with 3 and 2 pairs of setae respectively (Fig. 4); each parapside with 2 setae; axillae bare; scutum and scutellum with reticulate sculpture. Fore wings hyaline, three times longer than wide (0.63:0.21 mm) (Fig. 5); costal cell narrow; marginal vein slightly longer than submarginal vein (0.16:0.14 mm), the former with 8 setae; postmarginal vein rudimentary; stigmal vein short; marginal fringe short and are spaced by a distance equal to one-fourth their length. Hind wings hyaline, eight times longer than wide; marginal fringe longer than wing width. Legs orange yellow. Abdomen orange yellow except basal two segments which are infuscated; about as long as thorax (0.26:0.26 mm); ovipositor concealed.

Female length : 0.69 mm.

Holotype ♀, ex Aleyrodid on *Nerium*, INDIA, Tamil Nadu, Ootacamund, 24.vi.1968. Coll. S. Adam Shafee.

Paratypes. 6 ♀ (Same data as for holotype).

Trichaporus gunturensis sp. nov. (Figs. 6-8)

FEMALE: Head yellowish, wider than long in facial view; frontovertex about twice as long as wide; ocelli red, arranged in obtuse triangle, basal ocellus separated by more than twice its diameter from eye rim and twice its diameter from occipital margin; antennae inserted at lower level of eyes; malar space about as long as eye width; maxillary palpi 2-segmented, labial palpi unisegmented. Antennae (Fig. 6) yellowish; scape cylindrical, five times as long as wide, longer than basal two funicle segments together; pedicel twice as long as wide, distinctly longer than first funicle segment; funicle 4-segmented; first funicle segment shortest, one and a half times as long as wide; funicle segments 2-4 subequal in length, each twice as long as wide; club 2-segmented, four times as long as wide, slightly longer than preceding two funicle segments together. Thorax yellowish brown; mesoscutum and scutellum reticulately sculptured and with 4 and 2 pairs of setae respectively. Fore wings hyaline, three times as long as wide (0.6:0.2 mm); costal cell long and narrow; submarginal vein about as long as marginal vein; postmarginal vein rudimentary; stigmal vein short (Fig. 7); marginal fringe short, spaced by a distance equal to one-fourth their length. Hind-wings hyaline, about five times as long as wide; marginal fringe length more than the greatest wing width. Legs orange yellow except coxae which are dark. Abdomen orange yellow except basal two segments which are slightly infuscated; ovipositor concealed.

Female length: 0.72 mm.

Male antenna as shown in figure 8.

Holotype ♀. ex Aleyrodid on weed plant, INDIA, Andhra Pradesh, Guntur, Budampadu, 3.iii.1967. Coll. S. Adam Shafee.

Paratypes.—4 ♀, 3 ♂ (Same data as for holotype).

Trichaporus partenopeus (Masi) (Figs. 9-11)

Trichaporus partenopeus (Masi); Nikol'skaya & Yasnosh, 1966, *Opred. Faune. SSSR.* 91:267.

FEMALE: Head brownish, wider than long in facial view; frontovertex two and a half times wider than long; ocelli white, arranged in obtuse triangle, basal ocellus separated by twice its diameter from eye rim and by its own diameter from occipital margin; malar space longer than eye width; maxillary palpi 2-segmented, labial palpi unisegmented. Antennae (Fig. 9) yellowish; scape cylindrical, four times longer than wide, as long as basal

two funicle segments together; pedicel twice as long as wide, as long as first funicle segment; funicle segments 1-4 subequal in length, each slightly more than twice as long as wide; club 2-segmented, four times as long as wide, as long as preceding two funicle segments together. Thorax yellowish brown except one large patch on scutum and two small patches on scutellum which are dark; mesoscutum and scutellum reticulately sculptured and with 5 and 2 pairs of setae respectively. Fore wings hyaline, two and a half times as long as wide; costal cell narrow; submarginal vein shorter than marginal vein; postmarginal vein absent. Hind wings hyaline, seven times as long as wide; marginal fringe long, as long as wing width. Legs orange yellow. Abdomen orange yellow except base and lateral margins of dorsum which are infuscated; ovipositor concealed, arising from the base of abdomen.

Female length: 0.64 mm.

Material examined. 3 ♀, 2 ♂, ex Aleyrodid, INDIA, Maharashtra, Nasik, 4.v.1969. Coll. S. Adam Shafee.

ACKNOWLEDGEMENTS

We are indebted to Prof. S. Mashood Alam, Head, Department of Zoolgy, Aligarh Muslim University, Aligarh, for providing research facilities. Thanks are also due to Prof. Nawab H. Khan for encouragement.

REFERENCES

DOZIER, H. L. (1933): Miscellaneous notes and descriptions of chalcidoid parasites (Hymenoptera). *Proc. ent. Soc. Wash. 35*: 85-100.

NIKOL'SKAYA, M. N. (1952): The Chalcid Fauna of the U.S.S.R. (Chalcidoidea). *Opred. Faune. SSSR. 44*: 575 pp.

———— & YASNOSH, V. A., (1966): Aphelinidae of the European part of the USSR and the Kavkaza, *Opred. Faune. SSSR. 91*: 296 pp.

PECK, O., BOUCEK, Z. & HOFFER, A., (1964): Keys to the Chalcidoidea of Czechoslovakia (Insecta: Hymenoptera). *Mem. ent. Soc. Canada, 34*: 120 pp.

STUDIES ON THE SCARAB BEETLES (COLEOPTERA: SCARABAEIDAE) OF NORTH INDIA PART II. THREE NEW SPECIES AND TWO NEW RECORDS FROM INDIA[1]

S. BISWAS[2]

(*With four text-figures*)

Three new species, *Copris* (*S. str.*) *siangensis, Onitis assamensis* and *Drepanocerus kazirangensis* are described. Two species, *Drepanocerus runicus* Arrow and *Drepanocerus striatulus* Paulian are recorded for the first time from India.

1. Copris (S. str.) siangensis. sp. nov. (Figs. 1, 2)

MALE: Body elongated oval, highly convex, upper surface black and shining; mouth organs, antennae, legs and scanty hairs beneath reddish.

Head broad, almost semicircular, with a long, backwardly directed horn with two tubercles, placed posteriorly about one third dist-

[1] Accepted November 1978.

[2] Eastern Regional Station, Zoological Survey of India, Shillong-793 003, Meghalaya. *Present address*: Zoological Survey of India, 34, Chittaranjan Avenue, Calcutta-700 012.

ance from base; clypeus moderately strongly punctured, anterior margin reflexed and excised in the middle. Pronotum highly convex, strongly but unevenly punctured, anterior declivity feebly punctured and sides of mid-dorsal line almost smooth, upper margin of declivity with three sharp projections, middle one bifid at extremity; front angle blunt, truncated, hind angle obsolate, base rounded, lateral margin straight in front, rounded behind. Elytra strongly striate, striae closely punctured, interval a little convex, smooth and shining. Metasternal shield feebly punctured in the middle with a longitudinal groove; sides of metasternum bare, strongly punctured anteriorly. Front tibiae with 4 external teeth, apical spur broad toward apex. Pygidium strongly and uniformly punctured.

Measurement: Length, 12.0-13.5 mm; breadth 6.0-6.5 mm.

Holotype, ♂, collected from cattledung, India: Arunachal Pradesh, Siang: Along, 9.ii.1973 coll. R. S. Pillai, Regd. No. A1/4394. Paratypes 2 ♂♂, same data as for holotype.

Remarks: *Copris* (*S. str.*) *siangensis*, sp. nov. Comes near to *Copris* (*S. str.*) *delicatus* Arrow, but differs from the latter in having closely punctured clypeus and strongly developed prothoracic processes.

2. **Onitis assamensis** sp. nov. (Fig. 3)

FEMALE: Body broadly oval, not very convex; upper surface greenish, ventral surface brown, elytral suture and legs blackish.

Head subtriangular; with a short clypeo-frontal carina, posterior carina long, curved and entire, clypeus transversely rugulose, ocular lobes smooth, vertex deeply excavated, smooth posteriorly, finely tuberculate behind frontal tubercle. Pronotum very thinly and finely punctured anteriorly and laterally, closely and strongly in the middle near base; front angles sharp, hind angles obsolate, base rounded; lateral margin straight in front, feebly sinuate behind, mid-dorsal groove or line absent, basal fovae not large and separated from each other by more than the length of the fovae. Elytra broadly but shallowly striate, striae more broader laterally, intervals flat, not perceptibly punctured. Metasternum smooth, bare, flat, with a shallow longitudinal groove, base with two deep pits, sides of metasternum closely granular and hairy. Pygidium almost smooth without hair.

Measurement: Length; 23.0 mm; breadth, 12.0 mm.

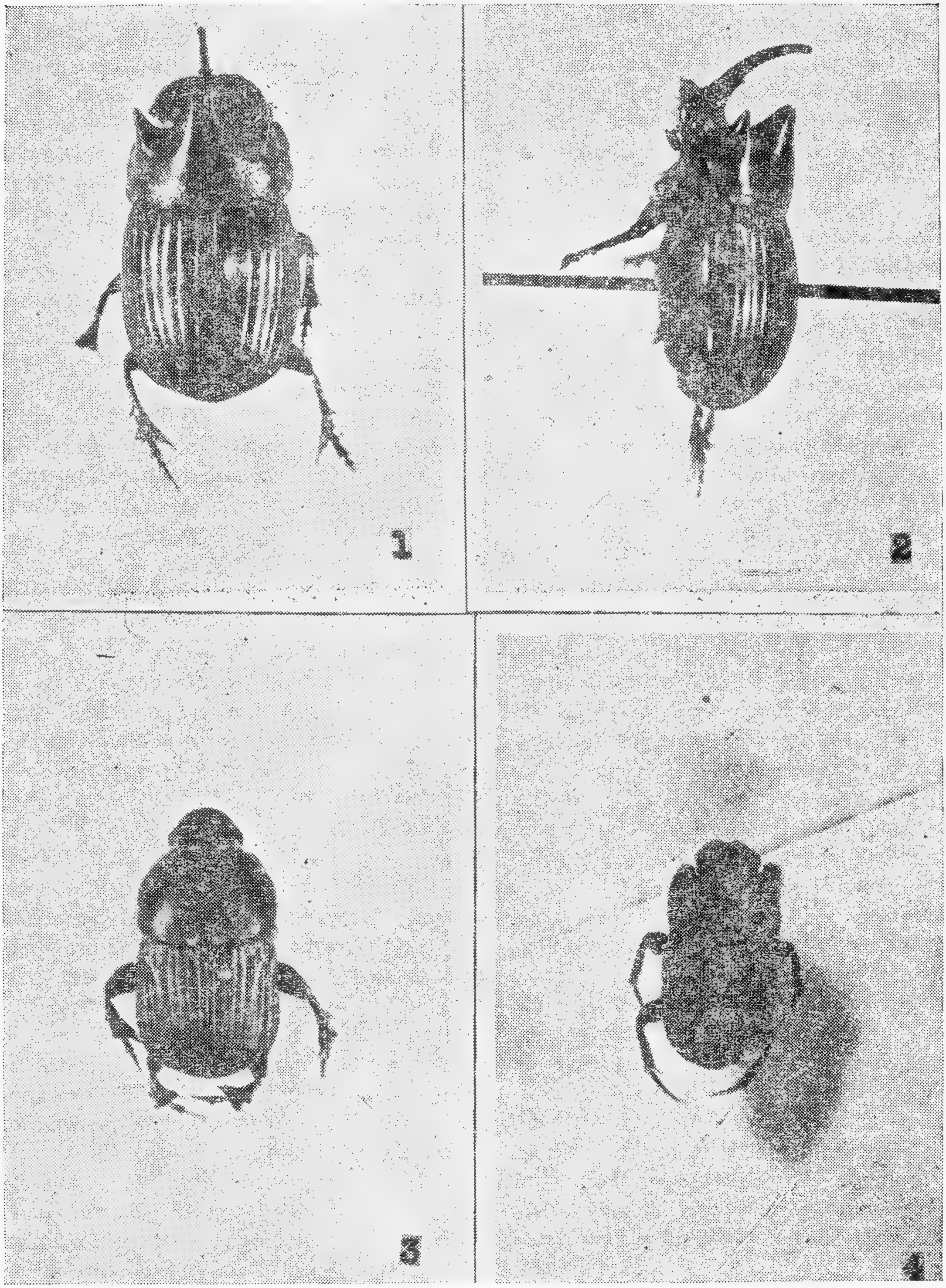
Holotype, ♀, collected from Rhinoceros-dung, India: Assam: Kaziranga National Park, 21.xii.1972, coll. A. K. Ghosh, Regd. No. A1/4397.

Remarks: *Onitis assamensis* comes close to *O. humerosus* Pallas, but differs from it in the (i) pronotum anteriorly being very sparsely and feebly punctured (ii) absence of hairs on clypeal disc. The species appears to be very rare and only one specimen has so far been collected from the decaying Rhinoceros dung on upland area of Central path in Kaziranga National Park.

3. **Drepanocerus kazirangensis** sp. nov. (Fig. 4)

MALE: Body elongated oval, black; antennae, mouth organs, tibiae, and tarsi brownish, and covered above and beneath with pale setae.

Head closely punctured, clypeal margin deeply impressed in the middle, rounded at sides, clypeo-ocular junction marked by carinate suture and strongly angulate in front of eyes. Pronotum without carina, horns and tubercle, closely covered with large umblicate punctures, a basal depressed pit near base, three more smaller ones on either side of basal



Figs. 1-2. *Copris* (*S. Str.*) *siangensis* sp. nov.: 1. Dorsal view; 2. Lateral view. Fig. 3. *Onitis assamensis* sp. nov.: Dorsal view. Fig. 4. *Drepanecerus kazirangensis* sp. nov.: Dorsal view.

depression anteriorly basal depression highly convex and gradually sloping in front, front angle blunt, hind angle obsolate, base rounded, lateral margin straight, feebly sinuate behind. Elytra narrowly striate, striae not very closely punctured, intervals covered with minute granules, 3rd interval convex anteriorly, 5th interval throughout the length with a setose ridge and 7th with an interrupted one behind shoulders. Metasternal shield vertical in front, middorsally convex anteriorly, rugosely punctured, more so behind; sides of metasternum closely covered with large shallow pits. All femora rugosely punctured, front tibiae with four external teeth, apical one directed foreword. Pygidium hollowed at base and apex, with an interrupted transverse ridge a narrow incomplete carina separating the basal depression into two halves. Last ventral sternite emarginate in the middle.

FEMALE: Same as male except with broad last ventral sternite.

Measurement: Length, 4.5-5.5 mm; breadth 2.5-3.0 mm.

Holotype, ♂, collected from dung of wild buffalo. India: Assam: Kaziranga National Park, 18.ii.1972. coll. G. M. Yazdani, Regd. No. A1/4777. Paratypes, 1 ♂, 4♀♀ data same as for holotype.

Remarks: *Drepanocerus kazirangensis* sp. nov. differs from *D. setosus* (Wied.), *D. sinicus* Harold, and *D. runicus* Arrow in having pronotum without any horn, carina or tubercle and from *D. striatulus* Paulian in having prosternum not being elevated behind front coxae. The species is peculiar in having single mid-dorsal depression in both sexes.

4. **Drepanocerus runicus** Arrow.

Drepanocerus runicus Arrow, 1931. Fauna Brit. India, Lamell., 3: 384.

Drepanocerus runicus Arrow, Balthasar, 1963. Monogr. Scarab. Aphod. palaearkt. orient; 2:66.

Arrow (1931) described the species from Burma: Karenhills: Asciuii Ghecu, Balthasar (1963) reported this species as being recorded also from Vietnam: Tonkin, Hoa Binh, Luc Nam. This is the first record of the species from India.

Material examined: INDIA: Assam: Goalpara, 4 ♂♂, 3 ♀♀, 17.i.1972. 1 ♂, 12.i.1972. North Cachar, 4 ♂♂, 3 ♀♀, 22.xi.1972. Manipur: Moreh, 3 ♂♂, 3 ♀♀, 21.i.1976. Meghalaya: Garo Hills, 9 ♂♂, 10 ♀♀, 8-15.iv.1973.

Remarks: Balthasar (op. cit.) considered the species to be rare. During the collection of Scarab beetles from different states in Northeast India it has been observed that the species is not rare but restricted to lower elevations upto *c* 1000 m. altitude and generally is not available in fresh dung. It is mostly confined to the dried crust of dung. When disturbed it withdraws its legs and remains motionless.

5. **Drepanocerus striatulus** Paulian

Drepanocerus striatulus Paulian, 1945. Col. Scarab. de L' Indochine: 138, 140.

Drepanocerus striatulus Paulian, Balthasar, 1963. Monogr. Scarab. Aphod. palaearkt. orient., 2: 69.

Paulian described the species from North Vietnam (Personal Communication). Balthasar (1963) reported this species as being recorded also from China (Kouy Tscheu). This is the first record of the species from India.

Material examined: India: Assam: Sibsagar, 2 ♂♂, 2 ♀♀. 22.xii.1972. North Cachar, 7 ♂♂, 8♀♀. 22.xi.1972. Lakhimpur, 10 ♂♂, 1 ♀, 8.xi.1972. Manipur: 9 ♂♂, 9 ♀♀, 23-25.iii.1975. Meghalaya: Garo Hills, 8 ♂♂, 7 ♀♀, 8-17.iv.1973.

Remarks: Balthasar (op. cit.) mentioned that the species is very rare. In Northeast India, however, the species may be considered to be common. His remark that the female of this species may be confused with those of *D. sinicus* Harold does not seem to be justified, as the species is peculiar in having much depressed body different types of elytral striae and prosternum elevated beyond the fore coxae, none of these characters is shared by *D. sinicus* Harold.

All types are at present in the collection of Eastern Regional Station, Zoological Survey of India, Shillong.

ACKNOWLEDGEMENTS

I am thankful to Dr. H. Khajuria for facilities, Dr. A. K. Ghosh for encouragement. My thanks are also due to Dr. R. Paulian Rector, Academy de Bordeux, France for kindly identifying *Drepanocerus striatulus* Paulian for me.

REFERENCES

ARROW, G. J. (1931): The Fauna of British India including Ceylon and Burma. Coleoptera, Lamellicornia Part III (Coprinae), London.

BALTHASAR, V. (1963): Monograpie der Scarabaeidae and Aphodiidae der palaearktischen und orientalischen Region (Coleoptera: Lamellicornia). Band I, II, Tschechoslo wakische Academic der Wissenschaften Prag.

PAULIAN, R. (1945): Coleopteres Scarabeides de l' Indochine, Faune de l' Empire Francais III. Paris.

TWO NEW SPECIES OF *BALOCHA* DISTANT (IDIOCERIDAE: HOMOPTERA)[1,2]

P. KAMESWARA RAO[3] AND
USHA RAMAKRISHNAN[4]

(*With twenty-three text-figures*)

Distant (1908) erected the genus *Balocha* with the type species, *Balocha tricolor* Distant from India. The species, *Idiocerus astutus,* described by Melichar (1903) from Nilgiri Hills was transferred to *Balocha* Distant by Maldanado (1964). Baker (1915) described *B. melichari* and *B. nacreatus* from Philippines. Further, Maldanado (1961) described *B. lucida* from Borneo and *B. pallida* from West Pakistan. Other species, subsequently added to genus *Balocha* are, *bicolor* from Borneo (Maldanado 1968), *maculifrons* and *pseudomaculifrons* from New Guinea and *unilineata* from New Britain (Maldanado 1970) This paper describes two more species of this genus.

KEY TO THE SPECIES OF *Balocha*

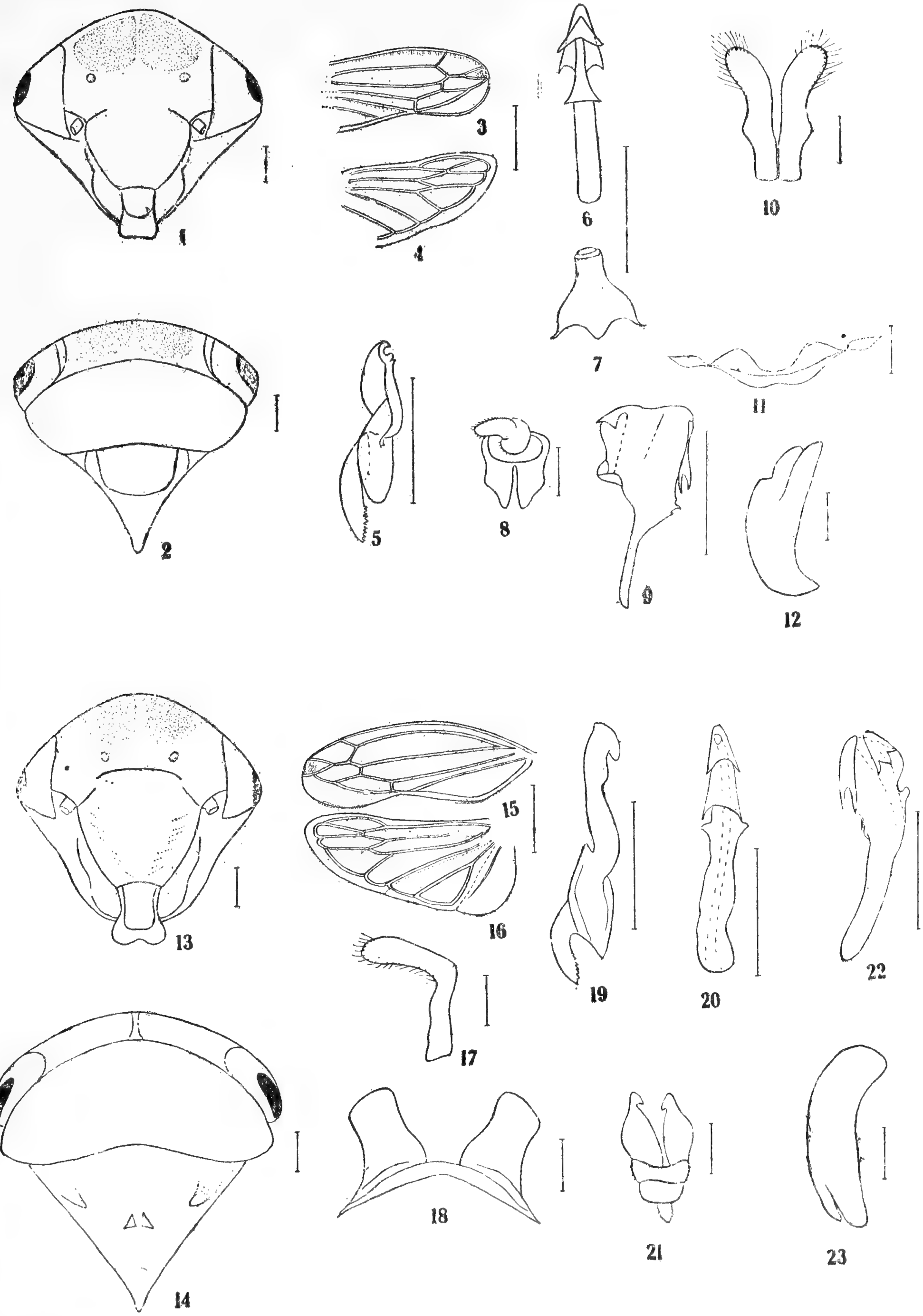
1. Face dark .... 2.
   Face not dark .... 3.
2. Forked cell in the fore wing with a very short

[1] Accepted November 1978.

[2] Part of the thesis of the senior author for the award of Ph.D. degree of I.A.R.I., New Delhi during 1976.

[3] Department of Entomology, A.P. Agril. University, Hyderabad-500 030.

[4] Division of Entomology, Indian Agril. Research Institute, New Delhi.



Figs. 1-12. *Balocha maldanadoi* sp. nov.: 1. face; 2. vertex, pronotum and scutellum; 3. forewing; 4. hind wing; 5. paramere; 6. aedeagus (caudal view); 7. connective; 8. anal tube appendages; 9. aedeagus (lateral view); 10. subgenital plates; 11. abdominal apodemes; 12. pygofer lobe. Figs. 13-23. *Balocha anufrievi* sp. nov.: 13. face; 14. vertex, pronotum and scutellum; 15. forewing; 16. hind wing; 17. subgenital plate; 18. abdominal apodemes; 19. paramere; 20. aedeagus (caudal view); 21. anal tube appendages; 22. aedeagus (lateral view); 23. pygofer lobe.

peduncle .... *B. maculifrons*
Forked cell in the fore wing with a very long peduncle .... *B. pseudomaculifrons*

3. Longitudinal veins in the fore wing blackened .... 4.
Longitudinal veins in the fore wing not blackened .... 5.
4. Fore wing smoky in colour......*B. melichari*
Fore wing not smoky in colour........... .... *B. unilineata*
5. Fore wings hyaline .... 6.
Fore wings subhyaline .... 7.
6. A piceous spot, present in the forked cell...8.
No piceous spot, present in the forked cell .... *B. astutus*
7. A brown spot present in the forked cell.... .... *B. bicolor*
No brown spot present in the forked cell.... .... *B. nacreatus*
8. Piceous spot in the forked cell extends to the outer apical cell .... *B. lucida*
Piceous spot in the forked cell does not extend to the outer apical cell.............9.
9. With an invested yellow arc across face including ocelli ....*B. tricolor*
Without the yellow arc across face including ocelli .... 10.
10. A very small brown spot present at the base of the appendix of fore wing.......*B. pallida*
No brown spot present at the base of the appendix of fore wing .... 11.
11. Abdominal apodemes short and rounded (Fig. 11); paramere chelate in cephalic portion (Fig. 5) .... *B. maldanadoi* sp. nov.
Abdominal apodemes subrectangular (Fig. 18) paramere (Fig. 19) nonchelate in the cephalic portion .... *B. anufrievi* sp. nov.

1. **Balocha maldanadoi** sp. nov. (Figs. 1-12)

This species resembles *B. pallida* but can be differentiated by the absence of a brown spot at the base of the appendix. Internally the paramere is bifid at the cephalic end of this species and this distinguishes it from *B. pallida*.

Fore wing (Fig. 3): Fore wing hyaline and narrow extending beyond the abdomen; appendix very broad, extending to the third apical cell, four apical cells, third apical cell petiolate, the peduncle shorter than the cell itself.

Hind wing (Fig. 4): Wings hyaline with well developed veins; submarginal vein complete joining the costal margin; apical cells four in number.

External male genitalia: Sub-genital plate (Fig. 10) long, slender, spatulate and upcurved with long hair in the apical half. Pygofer (Fig. 12) convex, broad in the middle and narrowed dorsally and ventrally. Anal tube appendages (Fig. 8) pointed at the end.

Internal male genitalia: Paramere (Fig. 5) elongated with its cephalic portion short and broad, bifid at its apex, the caudal portion with two arms. Connective (Fig. 7) Y-shaped. Aedeagus (Figs. 6 and 9) with its shaft cylindrical, very thin and long, gonopore apical.

Form: Postclypeus and anteclypeus slightly swollen (Fig. 1). Abdominal apodemes (Fig. 11) short and rounded.

Coloration: Fresh specimens greenish and preserved specimens orange yellow to orange red in colour. Castaneous band on the inner margins of eye. Interocular area above ocelli, lateral areas on postclypeus stramineus, scutellum and abdomen dorsally bright orange. Round piceous spot present on the eye (Fig. 2) and in the petiolate cell.

Measurements in millimetres of male: Length: total—4.18; head 1.59; vertex—0.28; pronotum 0.38; fore wing 3.50; scutellum 0.67; Breadth: Vertex 0.96; Pronotum 1.25.

Holotype ♂, INDIA, Pusa-Bihar, 16-xi-1933, H. N. Batra (Wings and genitalia on slides and rest on tag).

Paratypes 2 ♂♂, INDIA, Delhi 10-i-1975, 'Jamon', P.K.R.

2. **Balocha anufrievi** sp. nov. (Figs. 13-23)

This species comes nearer to *B. maldanadoi* sp. nov. but can be differentiated by the shape

of the abdominal apodemes and in the cephalic portion of the paramere being fan-like.

Fore wings (fig. 15) and hind wings (fig. 16) as in *B. maldanadoi* sp. nov.

External male genitalia: Sub-genital plate (fig. 17) and Pygofer (fig. 23) as in *B. maldanadoi* sp. nov. Anal tube appendages (fig. 21) hooked at the distal end.

Internal male genitalia: Paramere (fig. 19) elongated with its cephalic portion involuted and ending in a fan-like portion. Connective Y-shaped. Aedeagus (figs. 20 and 22) having its shaft narrowed at apex, gonopore apical.

Form: Anteclypeus longer than wide (fig. 13), convex lengthwise showing slight ridging. Abdominal apodemes (fig. 18) subrectangular.

Coloration: As in *B. maldanadoi* sp. nov. Piceous round spot, present in the pedunculate cell and on the eye.

Measurements in millimetres of male: Length: total—4.70; head—1.54; vertex—0.19; Pronotum—0.58; forewing—3.94; scutellum—0.96. Breadth: vertex—1.10; pronotum—1.40.

Holotype ♂, INDIA: Delhi: 10-i-1975; 'Jamon', P.K.R. (Wings and genitalia on slides and rest on tag).

Paratypes 5 ♂♂ (same data as for holotype).

All the figures were drawn with camera lucida except wings which were drawn with a microprojector. Lines were drawn to 0.2 mm. for all the parts except in case of wings which were drawn to 1.0 mm.

All the type specimens were deposited in the National Pusa Collections, Indian Agricultural Research Institute, New Delhi-110 012.

ACKNOWLEDGEMENTS

We are grateful to Dr. N. C. Pant, formerly Head of the Division of Entomology, I.A.R.I., New Delhi for the facilities and encouragement given.

REFERENCES

BAKER, C. F. (1915): Studies of philippine jassoidea, iv: The Idiocerini of the philippines. *Philipp. J. Sci. 10* (6): 317-342.

DISTANT, W. L. (1908): The fauna of British India. Rhynchota, iv: 184-190.

MALDANADO, C. J. (1961): Studies on Idiocerine leaf hoppers. 1. *Idiocerinus* Baker, 1915, Synonym of *Balocha* Distant, 1908, and notes on the species of *Balocha. Proc. Ent. Soc. Wash. 63* (4): 300-308.

————— (1964): Studies on *Idiocerinae* leaf hoppers: II The Indian and Philippine species of *Idiocerus* and the genus *Idioscopus.* ibid. *66* (2): 89-100.

————— (1968): Studies on Idiocerinae leaf hoppers. iv a new species of *Balocha* and one of *Pedioscopus,* mimics. ibid. *70* (2): 97-100.

————— (1970): Studies on *Idiocerinae* leaf hoppers. vi, New species of *Balocha* from papuan subregion (Homoptera: cicadellidae). *Pacific Insects 12* (2): 297-302.

MELICHAR, L. (1903): Homopteran-Fauna of Ceylon, pp. 148.

A NEW SPECIES OF *MOONIA* (HOMOPTERA: ULOPIDAE)[1,2]

P. KAMESWARA RAO[3] AND
USHA RAMAKRISHNAN[4]

(*With ten text-figures*)

Distant (1908 and 1916) described seven species of *Moonia, M. sancita* Distant (type-species) from Mussoorie Hills, U.P., and *albimaculata, capitata, brunnea, variabilis, diversa* and *albivitta* from Chikkaballapura, Nilgiri hills and Kodaikanal in South India. Kameswara Rao and Ramakrishnan (1978) added two more species, *M. immaculata* and *M. ixora* and one subspecies *M. sancita pomegranata* from Delhi. One more new species of *Moonia* is described in this paper from Delhi. The type specimens have been deposited in the National Pusa collections, New Delhi.

Moonia carinata sp. nov. (Figs. 1-10)

This species comes near to *Moonia variabilis* Distant and in the key given by Kameswara Rao and Ramakrishnan (1978) for the species of *Moonia* but can be differentiated from *variabilis* by the presence of a distinct carina on the postclypeus and well expanded gena. Internally the pygofer process of *variabilis* is more serrated at the apex than that of *carinata*.

The head, pronotum and surface of the fore wings of these hoppers show numerous pits.

Form: Face (Fig. 1) shows the postclypeus with a distinct longitudinal ridge; anteclypeus oval and distinctly separate from the postclypeus by a transverse depression; lora oval, distinctly marked off from adjoining sclerites; gena broad. Pronotum (Fig. 2) broader than long, convex and carinate medially.

Fore wing (Fig. 8): Fore wing broad, narrowed at apical portion; coriaceous thickly pitted, pits absent in the apical portion; veins prominently raised.

Hind wing (Fig. 9): Wings with well developed veins and three apical cells.

External male genitalia: Ninth sternum more or less triangular. Subgenital plate (Fig. 4) slender and long. Pygofer (Fig. 5) long and broad, posterior portion membranous bearing a spine like projection, mesially each lobe of the pygofer bears a flattened process (Fig. 7) which is irregularly toothed at the apex.

Internal male genitalia: Paramere (Fig. 6) elongated and arcuate with its cephalic portion short, narrow and rounded at apex, caudal portion long, broad and ending into a clubbed rounded apex. Aedeagus (Fig. 10) articulated to the connective (Fig. 3) by a short preatrium, atrial apodeme well developed, broader at the base than at apex, pointed, aedeagal shaft equal in length to atrial apodeme; gonopore subapical, almost at the mid-length of the shaft.

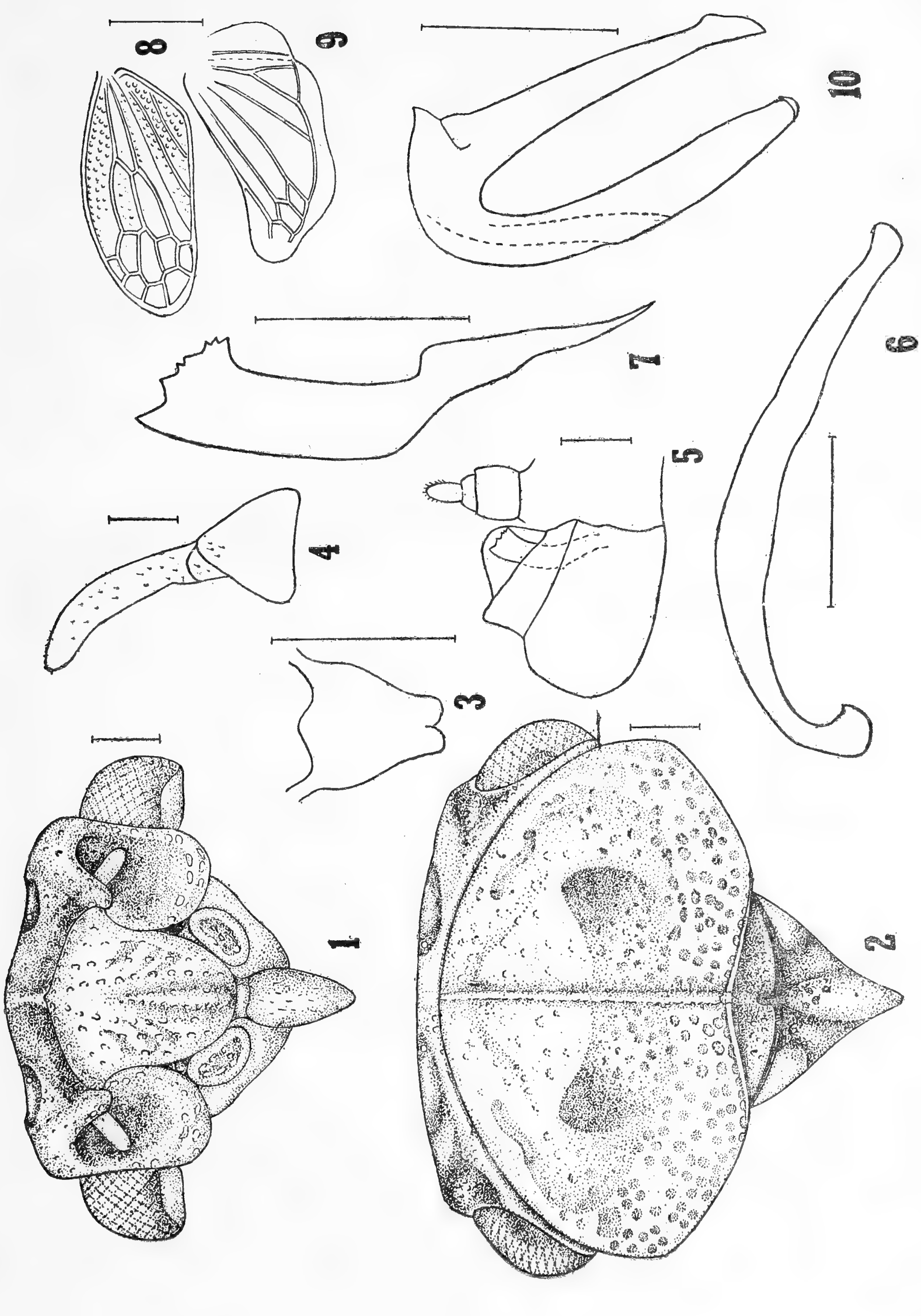
Coloration: Ochraceous specimens. The depression behind the anterior margin of frons,

[1] Accepted November 1978.

[2] Part of the Ph.D. thesis of the author submitted to Indian Agricultural Research Institute, New Delhi-110012 during 1975.

[3] Department of Entomology, A.P. Agricultural University, Hyderabad-500 030.

[4] Division of Entomology, Indian Agricultural Research Institute, New Delhi-110012.



Figs. 1-10. *Moonia carinata* sp. nov.: 1. face; 2. vertex, pronotum and scutellum; 3. connective; 4. subgenital plate; 5. pygofer with anal ring; 6. paramere; 7. pygofer process; 8. forewing; 9. hind wing; 10. aedeagus.

antennal pits, central portion of pronotum on either side of median dorsal carina, central portion of scutellum, piceous.

Measurements of male in millimetres: Length 4.32; Fore wing 3.17; Scutellum 0.72. All the drawings were drawn with a camera lucida except wings which were drawn with a microprojector. All the magnification lines were drawn to 0.2 mm except in case of wings which were drawn to 1.0 mm.

Holotype ♂, INDIA: Pusa-Bihar, "Duranta", 19-vii-1913, H. N. Batra (Wings and genitalia on slides and the rest on tag).

Paratype ♀, INDIA, Uttar Pradesh, Delhi, ex light, 27-vii-1974, P.K.R.

The type specimens have been deposited in the National Pusa Collections, New Delhi.

ACKNOWLEDGEMENT

Thanks are due to Dr. N. C. Pant, former Head of the Division of Entomology. I.A.R.I., New Delhi for the facilities and encouragement given in these studies.

REFERENCES

DISTANT, W. L. (1908): Rhynchota-Homoptera. The Fauna of British India including Ceylon and Burma, *5* (4): 197-198.

——— (1916): Rhynchota-Homoptera. Appendix. The Fauna of British India including Ceylon and Burma *6*: 233-236.

KAMESWARA RAO, P. AND RAMAKRISHNAN, USHA (1978): Studies on Indian Cicadelloidea (Homoptera: The genus *Moonia. Oriental Insects. 12* (2): 211-214.

A NEW SPECIES OF FERN FROM SOUTH INDIA[1]

N. RAVI[2] AND J. JOSEPH[3]

(*With five text-figures*)

Illustrated description of a new species of fern-*Grammitis pilifera* (Grammitidaceae) from Ponmudi Hills, Trivandrum District, Kerala State is dealt with.

Grammitis medialis (Bak.) Sledge affinis, tamer differt praesertim fronde, facie dorsali, hirsuto quam glabro; paleis rhizomatis peltatis quam basifixis; et sporangiis unisetosis.

Holotypus: Ponmudi Hills *Ravi* 5711 A (CAL); Isotypus *Ravi* 5711 B-E (MH) et Isotypus 5711 F (RH).

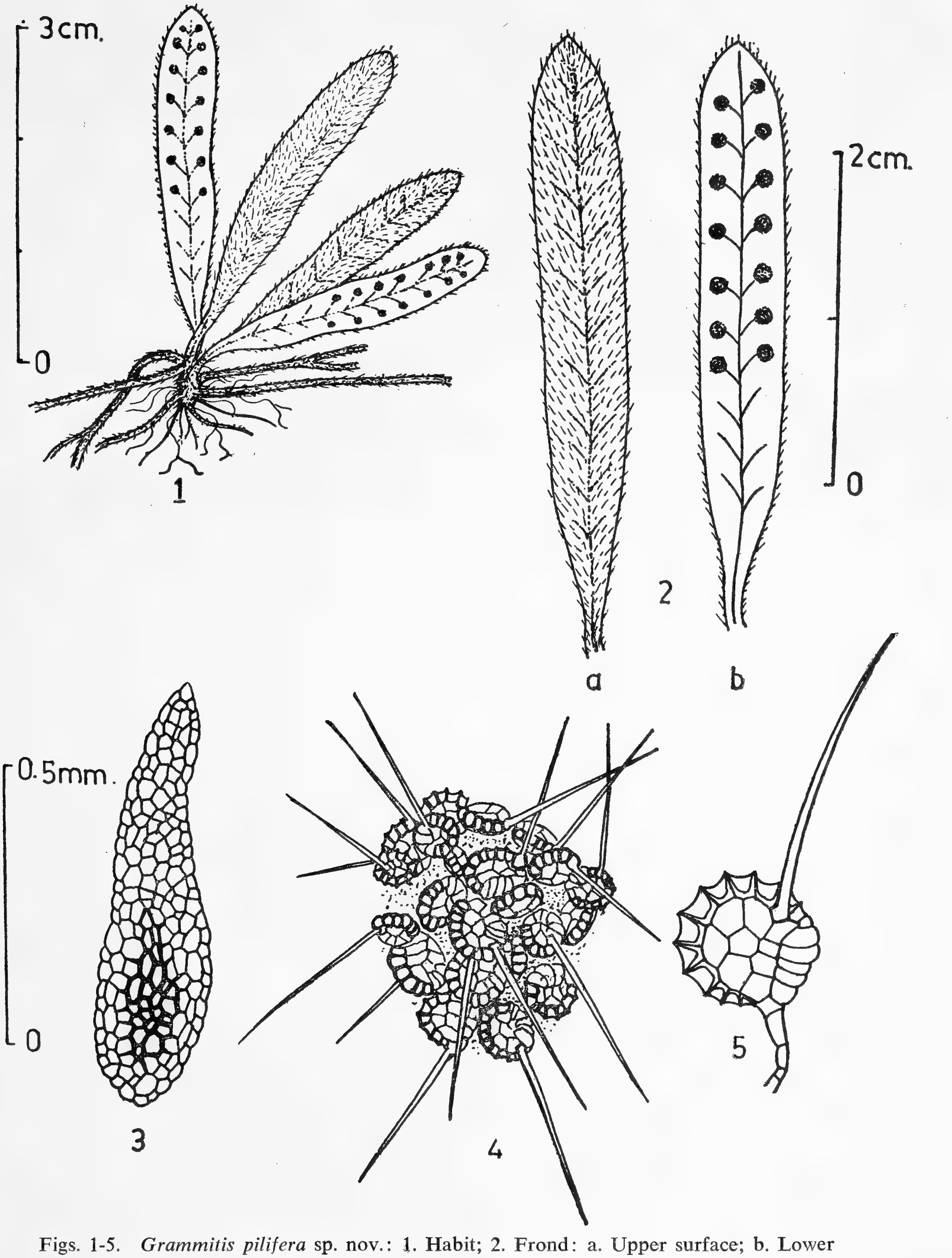
Grammitis pilifera sp. nov. is allied to *G. medialis* (Bak.) Sledge, but differs mainly in the frond being hirsute on the dorsal side instead of glabrous; scales on the rhizome peltate instead of basifixed and sporangia unisetose.

Ravi 5711 A collected from Ponmudi Hills, Trivandrum District, Kerala State, on 13th November, 1975 at 750 m. has been designated as Holotype and deposited in the Central National Herbarium, Calcutta (CAL), *Ravi* 5711 B-E (Isotypes) are deposited in the Regional Herbarium, Coimbatore (MH) and

[1] Accepted November 1977.

[2] Sree Narayana College, Sivagiri, Vaskala, S. India.

[3] Botanical Survey of India, Eastern Circle, Shillong.



Figs. 1-5. *Grammitis pilifera* sp. nov.: 1. Habit; 2. Frond: a. Upper surface; b. Lower surface; 3. Scale; 4. Sorus; 5. A single sporangium. (4 & 5 not to scale).

Ravi 5711 F (Isotype) at the Rapinat Herbarium (RH), St. Joseph's College, Tiruchirapally.

Grammitis pilifera sp. nov.

Epiphytic or lithophytic; rhizome short, erect, scaly at base with creeping branches and with unicellular slender brown hairs; scales ovate-lanceolate, peltate with sub basal attachment; the cells in and around the region of attachment dark coloured with thick walls, the remaining portions being pale brownish. Fronds $\pm$ 3×0.4 cm., subcoriaceous, oblong obtuse or subacute at tip, narrowed into a short stalk at the base; upper surface bristly hairy throughout; hairs purple brown; under surface glabrous; veins simple (or sometimes forked). Sori circular, median, at the tip of the veins without receptacular bristles; sporangia unisetose; setae arising from the junction between the ultimate and penultimate cells of the annulus, deciduous.

Grammitis pilifera grows on the branches of trees and on rocks along with mosses in shady places.

ACKNOWLEDGEMENTS

We are thankful to Dr. W. A. Sledge, University of Leeds, England for his help in confirming the identity of the new find and also in suggesting an appropriate specific name. Thanks are due to Rev. Fr. K. M. Matthew S.J., St. Joseph's College, Tiruchirapally for the Latin diagnosis.

REVIEWS

PAKSHIKALUM MANUSHYRUM: Pakshinirikshanathinu Oru Amukham (Birds and Men: An introduction to bird-watching). By K. K. Neelakantan, with a Foreword by Dr. Sálim Ali. pp. v + 80 (24 × 18.5 cm), with 67 text-figures. Trivandrum, 1979. The MacMillan Company of India Limited. Price Rs. 12.50.

A handy little book, comprehensive, summarised and updated in facts, rather a conglomerate of basic information that a young bird-watcher needs, it meets the need to arouse love for nature and interest in nature conservation in the minds of the young.

The book has twelve chapters in all and covers the role of birds in nature, basics of bird-watching, naming of birds in English, description of some common birds of India, flight, moult, migration, song and behaviour including mating behaviour and the relation between birds and men. It ends with a list of reference books useful for identification of birds and bird-watching for beginners and advanced bird-watchers. Eventhough the book is in Malayalam the English names of the birds are also given and the author stresses the importance of studying the scientific names of birds in English because of its universality in usage and usefulness in correspondence with bird-watchers from other states and countries.

Prof. K. K. Neelakantan, more familiar to Keralites by his pseudonym 'Induchudan', a retired English professor from Kerala University, is a life member of the Bombay Natural History Society and President of the Trivandrum wing of the Kerala Natural History Society. A book in Malayalam on Birds of Kerala (Keralathile Pakshikal), numerous articles in Malayalam Magazines, and a number of scientific articles and notes published in this *Journal* and elsewhere are among the author's valuable contributions to the art of Bird-study.

Nicely got up, well arranged, well printed and illustrated (unique in that all illustrations are by the author), this book will prove a useful guide for beginners in bird-watching.

The author and the publisher deserve to be commended on the timely publication of the book in the International year of the child.

An ardent nature lover himself and a competent bird-watcher Prof. Neelakantan meets his aim of showing students through this book that bird-watching is an enjoyable and thrilling hobby.

As Dr. Sálim Ali puts it in the foreword to this book, the non-Malayalee readers are deprived of the knowledge imparted by it and an English translation may prove useful.

S. M. SATHEESAN

A BUNDLE OF FEATHERS: Proferred to Sálim Ali on his 75th Birthday in 1971. Edited by S. Dillon Ripley II. pp. 241 (16 × 23 cm), with many illustrations and plates. New Delhi, 1978. Oxford University Press. Price Rs. 85/-.

We have in this volume a bundle of essays mainly on feathered bipeds proferred to the greatest Indian friend of them all—Dr. Sálim Ali by an international group of his friends and admirers. It is a most enjoyable book from which you will gleam a variety of fascinating facts. To mention just a few: while the north Indian bayas choose to nest on the babul tree, their south Indian brethren prefer the coconut tree; the half-a-million swiftlets from the great cave at Niah in Borneo consume no less than 20 million individuals of winged ants over the canopy of the rain forest every single day; the hill mynas imitate some of the calls of their neighbours of the same sex, but the call repertoire of the males and females is kept entirely distinct; the habits of the Himalayan honey-guides were accurately recorded by the authors of Chinese Materia Medica no less than a thousand years ago; many birds of high Andes and Tibet regularly use burrows of mammals for their nests; the starlings arrived in the North Americas with only three out of four lice that infect them in their original home in Europe; and, finally that our Indian cattle egret has prospered mightily in the U.S. over the last forty years. But the book is not a mere collection of interesting facts about the natural history of birds, it is a collection of some fifteen serious scientific papers ranging over the whole span of avian biology from biochemical changes in the migratory rosy pastor and the fauna of Narcondam islands to the migration of gannet in the Mediterranean and the role of birds in the natural foci of tick-borne arboviruses. The authors also range over the three continents of North America, Europe and Asia and include many leading ornithologists of the world.

The book is divided into four sections. The first is biographical and includes a most charming portrait of Sálim Ali by Zafar Futehally. The second section on life history and field biology has eight papers; of these I particularly enjoyed two. Tom Harrison's paper on the food of swiftlets at the Niah great cave in Borneo is a model of careful field work half-a-million swiftlets in this cave spread far and wide over the forest canopy and specialize on winged ants and termites. Harrison looks carefully at the composition of the diet of the two species and provides new insights into their role in the ecosystem. Yu A Isakov's paper on the great bustard, *Otistarda* is a fascinating account of the historical changes in the pattern of land use in Central Asia and Europe and the consequent rise and fall of the populations of the great bustard.

The section on zoogeography and systematics has seven papers, beginning with an interesting one on the discontinuous distribution of *Muscicapa latirostris.* The Stressemann's show that the one isolated population on the island of Sumba has diverged from the palaearctic populations, while those nesting in India, coming under the swamping influence of the migratory population do not do so. Theresa Clay in a paper on the distribution of bird lice brings out how these can be used to elucidate phylogenetic and distributional history of their bird hosts.

The last section deals with migration, biomedicine and learning. It contains a scholarly article by Netsky, Malkov and Bogdanov on the role of birds, ticks and mosquitoes in the natural foci of tick-borne arboviruses. Landsborough Thomson traces the migration of the Gannet and shows that the first year birds are much more apt to disperse, and that the birds do not migrate to the Balkan Sea the way they do into the Mediterranean.

All in all very varied and interesting fare. The articles differ widely in the originality of new information presented, the care with which it is analysed, breadth of the subject under review, the rigour of the argument and readability of the language. Some, such as the fauna of Narcondam islands is merely descriptive and of limited technical interest. Horace Alexander's article on what leads to an increase in the range of certain birds is a mere summary of well-known facts with what appear to me to be completely unjustifiable hand-waving arguments on the possible changes in the central part of the range of the birds. It is nevertheless a very readable article. Others such as the one on the biology of the olivaceous leaf warbler of the Tian-shan mountains present a lot of new data, but are somewhat difficult to read. Then there is Thorpe's masterly review of bird vocalization with special emphasis on duetting.

Taken altogether, there is something for everybody, but no substantial contribution of a type which would render the book an indispensable item in an ornithological or a bird-watcher's library. It may have been a much more important book if, for example, a theme had been chosen and a series of authoritative reviews on that theme brought together. The theme could have been conservation of bird species or bird migration; areas to which Sálim Ali has contributed so much. Or else it could have been a book in which professional ornithologists could have recounted major developments in avian biology in simple language for the amateur bird-watcher for whom again Sálim Ali has done a great deal through his bird book. But this caveat apart, I heartily recommend this bundle of feathers to all bird lovers the world over.

MADHAV GADGIL

FLORA MALESIANA—Series I—FLOWERING PLANTS, Vol. 8. General editor Dr. C. G. G. J. van Steenis. pp. i-cxv + 577 (17 × 24 cm) in three parts. The Netherlands, 1974-1978. Sijthoff & Noordhoff International Publishers.

Part I (1974) contains 2 articles:

A. CYCLOPAEDIA OF COLLECTORS AND COLLECTIONS—Supplement II by M. J. Van Steenis-Kruseman. Pp. i-cxv. This second and final supplement is in continuation of the supplement I (Flora Malesiana I : Pt. 5, 1958, pp. ccxxxvii-cccxlii). It contains an impressive list of 1049 collectors with their brief biographia, main contributions and photographs in many entries. It is a highly creditable work on the part of the compiler. An addenda to the 6 chapters of the main work is also appended. The information given here is relevant to all the students of tropical plants including India, where a large number of

floristic elements commonly occurring in Malesia are extant. The whole work is of interest to students of Indian floristics.

B. Revision of the family HYPERICACEAEA by N. K. B. Robson, pp. 1-29, figs. 20. This small family is expertly treated by the author. It gives distribution, ecology, anatomy, palynology, embryology, cytology and chemotaxonomy. The author feels Hypericaceae does not deserve the family rank and should be treated as a sub-family of Guttiferae. The following genera are treated: *Cratoxylum* (6 spp) and *Hypericum* (15 spp).

Part II: SYSTEMATIC REVISIONS (1977)

(i) ULMACEAE by E. Soepadmo (pp. 31-76, Figs. 27) contains generic description and brief notes on distribution, fossils, ecology, anatomy, palynology, embryology, cytology, chemotaxonomy and phylogeny. It treats 6 genera and 27 species (*Ulmus*-1, *Parasponia*-5, *Trema*-4, *Celtis*-9, *Aphananthe*-2 and *Gironniera*-6).

(ii) IRIDACEAE by D. J. L. Geerinck, pp. 77-84, figs. 6. Contains brief notes on distribution, ecology, morphology and uses. 6 genera are treated: *Patersonia* (1 sp.), *Sisyrinchium* (2 spp), *Belamcanda* (1 sp.), *Eleutherine* (1 sp.), *Gladiolus* (1 sp.) and *Trimezia* (1 sp.)

(iii) CORNACEAE by K. M. Matthew, pp. 85-97. Figs. 6. Treats the genus *Mastixia* with 10 spp. and several subspecies.

(iv) ONAGRACEAE by P. H. Raven, pp. 98-113, figs. 10. Contains brief notes on distribution, dispersal, pollination, morphology and anatomy, chromosomes, hybridization and chemotaxonomy. Two genera—*Ludwigia* (8 spp.) and *Epilobium* (2 spp.) are treated. 2 species of *Fuchsia* and *Oenothera* (1 sp.) which occur in cultivation are also mentioned.

(v) BIGNONIACEAE by C. G. G. J. van Steenis, pp. 114-186, figs. 39, gives notes on distribution, flower biology, pollination, dispersal, germination, taxonomy, genetics, palynology and chemotaxonomy. 30 species under 15 genera are treated. 27 spp. of cultivated plants are added.

(vi) CRYPTERONIACEAE by R. J. van Beusekom-Osinga, (Pp. 187-204, figs. 13) gives notes on distribution, ecology, morphology, anatomy, taxonomy and uses. 3 genera *Crypteronia* (4 spp.), *Dactylocladus* (1 sp.) and *Axinandra* (3 spp.) are treated.

(vii) SYMPLOCACEAE by H. P. Nooteboom, pp. 205-274, figs. 20. *Symplocos* is treated under 2 subgenera *Symplocos* and *Hopea*. 58 species and several subspecies are treated.

(viii) LENTIBULARIACEAE by P. Taylor, pp. 275-300, figs. 26. *Utricularia* with 22 species is well treated under distribution, ecology, pollination, genetics and morphology.

Part III—SYSTEMATIC REVISIONS is dedicated to the memory of F. A. W. Miquel, whose biography and main works are appended. pp. 1-16. List of abbreviations and signs are given on pp. 17-19.

(ix) LABIATAE by H. Keng, pp. 301-394, figs. 32, is treated with notes on distribution, ecology, dispersal, palynology, phytochemistry. Taxonomy and uses have been summarized. An elaborate key to 32 genera is provided. In all 87 species and 10 subspecies are treated. Cultivated plants are also noted.

(x) ANACARDIACEAE by Ding Hou, pp. 395-548, figs. 69 is treated with notes on Distribution, morphology, dispersal, galls, germination, taxonomy, phytochemistry, chromosomes, uses etc. 22 genera and 151 species are given. An addenda, Corrigenda et emendanda is given on pp. 549-552 concerning systematic revisions given in Vols. 4, 5, 6 and 7.

Index to scientific plant names is appended on pp. 553-577.

On the whole this volume containing revisions of 10 interesting families which are common in this part of the world contains very valuable information worked out by well-known scholars in plant taxonomy and will prove very useful to the systematic botanists in India.

P. V. BOLE

THE OXFORD BOOK OF TREES: By A. R. Clapham. Illustrated by B. E. Nicholson. pp. 216 (18 × 24 cm) with many coloured and Black-and-White illustrations. London, 1975. Oxford University Press. Price £4.95.

One of a series of several publications on plant and animal life in Britain, this fascicle is truly fascinating particularly on account of its illustrations of which more than 500 are in colour.

The introduction tries to explain differences between trees and shrubs with reference to the woody vegetation of Britain. It defines with the help of suitable illustrations the shapes and types of trees and their variations.

The main text gives an enumeration of native British trees with their habit such as woodlands, wet-places and hedges. It differentiates the conifers and has separated the trees introduced to Britain from other parts of the world.

Each of the species described is superbly supported by the fascinating colour portraits by Barbara Nicholson. A key to identify the various genera and species of trees is appended together with a glossary, further reading references and general index. Winter aspects of about 30 species are drawn on the inside covers of the book.

This book excels in production value, is moderately priced and can be considered an essential reference work for any student of temperate tree flora. All public libraries must have such an excellent production for reference.

P. V. BOLE

MISCELLANEOUS NOTES

1. THE SURAT DANGS REVISITED

During the summer of 1976 Mrs. Shull and I revisited India. It was a real thrill, with some disappointments, to return to Ahwa, district headquarters of the Dangs, after an absence of twelve years. We had lived at Ahwa from 1951 to 1964, enjoying the "exotic" flora and fauna.

Some noteworthy changes were evident. The improved forest resthouses (with their electric lights), roads, and buses greatly facilitated travel throughout the area; but, it was still the jeep that made travel over washed-out roads possible. The monsoon had arrived early in June, so our trip to Mahal and other villages from June 18th to 25th was occasionally hazardous.

In Ahwa, there was a substantial decrease in the number of teak trees (*Tectona grandis*) and in the various species of bamboo. As we moved throughout the Dangs, it became clear that the formerly accepted cycle of replanting the teak was not keeping pace with the extensive cutting of timber for roundwood. Also the hill tribes were denuding the trees by cutting off the branches for firewood, a scarce fuel in the Dangs and many other parts of the world. At Mahal, the former tall clumps of bamboo were nowhere to be found. Other bamboo varieties were rapidly disappearing from Mahal and other areas; the hills and valleys looked bare. The bamboo was being transported to the paper pulp mills of Gujarat. As India's population of people increases, the need for lumber and paper likewise increases. Thus two of the finest resources of Gujarat State—teak and bamboo—are not being conserved for future generations to enjoy or to use.

Our travel in the Dangs District did not disclose a leopard, tiger, chital, sambar, wild boar, or any of the large mammals. In America we read about the plight of the tiger. With Project Tiger now being supported on an international level, it is our hope that this magnificent animal will survive. The situation in the Dangs is not encouraging.

Habitat destruction, more than hunting, seems to be destroying, or seriously reducing, the flora and fauna of the Dangs. Until India's population growth subsides, as it has in Singapore, the destruction of natural habitats and natural resources will likely continue.

As I assess the situation in the Dangs, the tiger has become rare, the leopard or panther survives but reduced in numbers; whereas, the Axis deer or chital, sambar and wild boar are fewer than in the 1950's and 1960's.

The destruction of the forested areas in the Dangs has apparently reduced the number and kinds of birds. Normally the early monsoon season is an exciting time to see our feathered friends, but again our observations were minimal. Through the rolling hills and valleys from Gulchond to Saputara we saw only two large Racket-tailed Drongos (*Dicrurus paradiseus*) and a few Black Ibises (*Pseudibis papillosa*), formerly not uncommon birds in this area. Flycatchers, cuckoos, bulbuls, hawks, owls, and the formely ever-present vultures were either absent or greatly

reduced in numbers. Even the once common kingfishers were absent.

In the 1960's the mercury vapour lamp on the compound of the Ahwa ST stand attracted a great variety of moths and other insects, lizards, frogs, bats and other small insect-eating animals. In 1976 this same lamp attracted only a few of these; however, one partial explanation might be the presence of many powerful electric lights now in the town. Still very few species of moths, butterflies, and skippers were observed throughout the Dangs. Also the depletion of flowering plants has no doubt contributed to the decreased number of Lepidoptera.

Nature — even when left undisturbed— maintains a sensitive balance between the flora and fauna. Man is the culprit responsible for upsetting the natural order. The very survival of *Homo sapiens* most likely depends on the balance of nature being preserved. After all, the future of the earth might be with the insects rather than with man. Can man survive? That question will be raised more seriously by the time man enters the twenty-first century.

ERNEST M. SHULL

402 N. Wayne Street,
North Manchester,
Indiana, 46962, USA,
February 2, 1978.

2. A NOTE ON THE TIGER CENSUS CONDUCTED IN GUJARAT STATE FROM 15TH TO 21ST APRIL, 1979

A census of tigers in the Gujarat State was carried out from 15th to 21st April, 1979. A brief account of the same is given below.

Initially, the following potential tiger areas of the State were proposed to be covered during the census:
This census area covered a total of 275 beats, the beat being the territorial unit for the census.

Detailed cyclostyled instructions in the vernacular on the census methodology were supplied to each Beat Guard. The period from 3rd to 5th April was earmarked for collecting preliminary census information so as to determine the areas where tigers or their signs were reported during the last 12 months. On the basis of this information, the final census was confined to the following areas:

Name of Circle	Name of Forest Division	Name of Range
Surat	Dangs (North)	All Ranges
	Dangs (South)	—do—
	Valsad	Bansda (including the Bansda National Park areas). Pangarbari and Fatepur
	Vyara	Vajpur Range covering Satkashi forest
	Rajpipla (West)	Mandvi (North) Mandvi (South)
	Rajpipla (East)	Dediapada, Fulsar, Piplod, Rajpipla, Sagbara.
Gandhinagar	Banaskantha	Danta and Ambaji.

Dangs (North) and Dangs (South) Divisions; Bansda Range of Valsad Division; Rajpipla Range of Rajpipla (East) Division and Ambaji Range of Banaskantha Division.
Throughout the census week, each Beat Guard within the census area did intensive patroling within his jurisdiction (with the help of hired trackers where necessary), specifically for the purpose of detecting signs of tiger movement in his area (such as actual sighting, pugmarks, droppings, kills, etc.). Any positive report received from them were immediately verified on the spot by a responsible officer (Range Forest Officer, Asst. Conservator of Forests or Dy. Conservator of Forests). Wherever pugmarks were found, they were recorded on a tiger tracer indicating the location and time. A blueprint showing the actual size samples of tiger pugmarks (male, female and cub) were supplied to each Beat Guard for his guidance in the field and to eliminate the possibility of panther pugmarks being mistaken for a tiger's.

In all, 11 cases of direct or indirect tiger sightings were reported at the end of the census period from Dangs (North), Dangs (South) and Rajpipla (East) Divisions, of which only 7 were finally accepted as enumerated below:

Thus, in the final analysis, it can definitely be recorded that there were 7 tigers in Gujarat State during the census period from 15th to 21st April, consisting of 4 males and 3 females distributed over the following divisions:

Dangs (North)	:	3 males and 2 females
Dangs (South)	:	1 female
Rajpipla (East)	:	1 male

Advantage of this tiger census was also taken to estimate the population of panthers in Dangs District, i.e. Dangs (North) & Dangs (South) Divisions. These observations indicate that there are approximately 70 panthers in this District, which can be considered to be a fairly substantial number.

During the last all India Tiger Census conducted in 1972, 8 tigers had been reported from Gujarat State, all of them from Dangs District. As against this, the present census has indicated the existence of 6 tigers in Dangs District and one in Rajpipla (East). Division (Bharuch District). It appears quite obvious that the tiger in Gujarat is struggling for survival and its population in the State is on the decline. The main adverse factors which the tiger has to face may briefly be enumerated as under:

A steady reduction and constant human disturbance in its habitat. Among the more serious causes of disturbance may be mentioned the industrial exploitation of bamboos, intensive management of the forest (particularly in Dangs), the collection of minor forest produce by the tribals resulting in recurring forest fires, and the heavy depletion of wild ungulate population due to persistent poaching by the tribals, particularly during the critical summer months. With hardly any natural prey left for the tiger, it is compelled to turn to domestic cattle. But here also he has to face severe competition because the moment a kill is detected, the local tribals rush in to drive the tiger away from his kill and to appropriate the meat for their own consumption. It is virtually impossible for the tiger to survive under these conditions, although the panther can always manage to eke out a living even under such unfavourable conditions.

Acknowledgements

The following non-officials very kindly assisted in the census as non-official observers, Mr. Digveerendrasinhji I. Solanki, Jamshedji D. Gabba, Dr. Neumann T. Mascati, Mr.

Kasimkhan J. Khan and Madhusudansinhji of Danta. I would like to place on record my deep sense of gratitude to all these gentlemen for having so kindly offered their voluntary services for the census work, particularly Shri Digveerendrasinhji and Shri K. J. Khan who ungrudgingly spared their valuable time and took a lot of trouble at considerable personal discomfort to tour the forest areas extensively for the verification of pugmarks, etc.

M. A. RASHID

ADDL. CHIEF CONSERVATOR OF FORESTS,
(WILDLIFE), GUJARAT STATE,
VADODARA,
July 16, 1978.

3. OCCURRENCE OF CIVETS IN THE CITY OF RANGOON (BURMA)

During the war period (January 1942—May 1945) as I returned home late one night from the Orient Club on the Royal Lakes (Kandawgyi), I saw in the beam of my car light a large Civet which ran across the road in the Golden Valley area.

Since 1954, I have been residing in the Inya Myaing area which adjoins the Golden Valley area. Inya Myaing is $4\frac{1}{2}$ miles from the General Post Office, Strand Road. Adjoining my compound on one side is The International Meditation Centre. The compound is over an acre in area with a number of large trees. I planted a number of plum and guava trees around my cottage. The branches of these trees drop on the roof of my cottage.

A few years after our arrival, a large Civet took up its abode under the roof of my cottage. It climbed to its abode by a guava tree. It came to its abode early in the morning and left its abode to feed at dusk. I saw the Civet resting on the roof on one or two occasions during the day. It had black stripes on the back, the long tail also being banded with black and could have been the banded palm civet (*Hemigalus derbyanus* Gray).

After the disappearance of this civet and a break of several years a pair of civets took up their abode under the roof of my cottage. They climb to the roof and descend from the roof by a plum tree. They leave their abode to feed between 1900 and 2000 hrs. and return to the abode between 0400 and 0500 hrs. next morning. We know when they leave and when they return by the noise they make when moving about and by the noise caused by the branches of the plum tree striking the roof.

They were not much of a nuisance at first. But in 1977 they bred two young. They are a nuisance now from the cries of the young and from their urine. The urine drips through the ceiling down to the floor all over of my cottage and is not confined to one place only. It has a very strong odour and the floor has to be washed immediately before it dries up.

I have sat up at night fall as well as early in the morning on several occasions but have not been fortunate to observe any of the civets. On one occasion during the day I observed two tails dropping down through an aperture in the ceiling. The tails are not banded. The house maid, however, has been fortunate. She observed through a window in her dormitory the two adults coming down from the abode at night fall and returning to the abode early

next morning on a number of occasions. She observed also the family frolicking on the lawn during clear weather on more than one occasion. I showed her plates of civets. She picked out the plate of the Masked Palm Civet (*Paguma larvata larvata*).

The civets can either be the Tenasserim white whiskered Palm Civet *Paguma larvata janetta* Thomas or the Himalayan Palm Civet *Paguma larvata neglecta* Pocock.

The caretaker of the International Meditation Centre informed me that there are two species of Civets in their Centre. On one occasion, the two fought and one was killed. He identified the dead civet as *Kyaung-na-ga.* Malayan Palm Civet (*Paradoxurus hermaphroditus pallasi* Gray).

As regards the second species he said the civets he saw are similar to the Common Palm Civet or Toddy Cat (*Paradoxurus hermaphroditus*).

TUN YIN

25, Inya Myaing Road,
University P.O.,
Rangoon, Burma,
July 24, 1978.

4. AN INSTANCE OF WILD DOGS SCAVENGING ON A TIGER'S KILL

On the morning of 24th July 1978 Keechanna, my tribal boy, came across Jungle crows calling near a forest road two kilometres from Bandipur campus. As he walked along the road looking at the crows he failed to see a tiger lying 3 metres from the road. The tiger was also looking at the crows and so it did not see Keechanna who had gone as close as ten metres to it. When he saw the tiger he silently retreated for 60 metres climbed a small *Butea frondosa* tree and observed. Once the crows 15-20 in number alighted on the kill, a prime adult sambar stag with 48 cm velvet antlers, which was 8-10 metres from the tiger. The tiger with a whoop ran to, chased the crows and returned to its 'bed'. Tigers are intolerant of vultures also and on occasions they may even kill them (Schaller 1967).

I had gone to another part of my study area and when Keechanna informed me of this around 1000 hrs, in his company I hurried to the spot. When we were 50 metres from the spot, at 10.30, I saw the tiger walking to the road from the kill. Hurriedly and silently we moved to the cover of the *Butea* tree trunk and watched. The tiger remained on the road for 3 minutes. Three times it flexed its tail arching over its back and once it lay down for a few seconds. At 1033 the tiger went back to the kill. We were in an active elephant country close to a much used pool. Since there was no suitable tree we left the place.

In the evening my wild dog pack was seen 500 metres from Bandipur but it eluded us and went to the kill. We did not hear any altercation between the tiger and the wild dog but repeated sambar belling was heard. Next morning around 1000 hrs we went to check the kill. This time we were accompanied by S. N. Prasad one of the students of Dr. Madhav Gadgil. The wild dogs had eaten a good amount of meat from the kill but on the wet muddy road there was no sign of either excited running or of struggle. The

tiger, most probably before the arrival of the dogs, while dragging the kill had severed a portion of the carcass with the head, neck and anterior part of thoracic region with 3 ribs and had dragged it nearly 80 metres from the major part of the carcass. While looking for the missing part I saw a pit with some water where the sambar had been killed. After killing, the tiger had eviscerated and removed the rumen contents. Then it had dragged the kill for 20 metres and left it under a stand of *Kydia calycina*.

Meanwhile Keechanna found the drag mark and while we followed and found it the tiger from the cover coughed three times. On the throat of the sambar there were four canine marks. Here it would be pertinent to record that the tiger and the lion while killing large prey prefer to bite on the throat (Schaller 1967, 1972) though Krishnan (1972) has found an adult Gaur cow with two sets of two deep punctured wounds, inflicted by the canines of a tiger on either side of a nape. After removing the jaw we returned to the road, and the tiger remained hidden and growled two times from a distance of 50 metres. Since coughs and growls are the early warning signals of a tiger which wants to discourage people disturbing it (Corbett 1957) we went away.

In the evening Keechanna was taken by the local Forest staff to show the kill and he found that the tiger had eaten most of the meat from the major part of the carcass. He did not take them to the other spot. Next morning we saw the pugmarks on the tracks of the van and the remains close to the road were licked clean. As the crows were calling from trees around the other area we did not venture to check.

I was not able to deduce the exact cause which prevented the wild dogs from following the drag marks of the smaller portion of the kill. May be they had sufficient meat on the major part of the kill or were reluctant to face an irritated tiger in the scrub. When there was sufficient meat left on a kill the wild dogs most often revisited the kill. In this case, however, the wild dogs did not do so. The presence of the tiger did not permit us to weigh the remains so as to calculate the amount of meat eaten by the tiger and the wild dog. From the above incident, with certainty one can infer, that wild dogs can scavenge on tiger's kills and a tiger may amicably withdraw in the presence of 15-16 dogs. This withdrawal may only be temporary and a tiger can operate in an area frequented by wild dogs.

A. J. T. JOHNSINGH

VISITING SCIENTIST,
CENTRE FOR THEORETICAL STUDIES
INDIAN INSTITUTE OF SCIENCE,
BANGALORE-560 012,
October 10, 1978.

REFERENCES

CORBETT, J. (1957): Man-eaters of Kumaon. London.

KRISHNAN, M. (1972): An ecological survey of the larger mammals of Peninsular India. *J. Bombay nat. Hist. Soc. 69* (1): 26-54.

SCHALLER, G. B. (1967): The Deer and the Tiger. The University of Chicago Press, Chicago.

——————— (1972): The Serengeti Lion. The University of Chicago Press, Chicago.

5. ON THE VALIDITY OF *FRANCOLINUS PICTUS PALLIDUS* (J. E. GRAY)

When cataloguing the Painted Partridges (*Francolinus pictus*) from Indian limits in the Society's collection (1969, *JBNHS* 66: 257-258), I said there was much variation in the patterns both above and below, but with the material available (31 specimens none from near the type locality) it was not possible to separate any as *pallidus* (J. E. Gray, type locality Udaipur) from nominate *pictus* (Jardine & Selby, Bangalore).

With the assistance of Mr. Amrendra Singh of Udaipur, we have now been able to obtain a male from near Udaipur, the type locality, dated 1 September 1977 (BNHS Reg. No. 24381), which is distinctly paler than any of the others. This paleness is most prominent on the wings and is generally emphasized by the pale streaks in the form of paler edges to the dark feathers on the head. The last character is visible in only one other skin from Mt. Abu (o? 13746) and which does show an appreciable tendency towards *pallidus*. In any case, it would appear that this form does exist but covers a very restricted range.

75, Abdul Rehman Street,
Bombay-400 003.
August 7, 1978.

HUMAYUN ABDULALI

6. INCUBATION AND INCUBATION PERIOD IN THE INDIAN LITTLE BROWN DOVE *STREPTOPELIA SENEGALENSIS*

A pair of Indian Little Brown Dove *Streptopelia senegalensis* managed to construct a nest in the veranda of my house in Baroda. Soon after the construction work of their nest got over, the eggs were laid, one each on successive days, namely on 29th and 30th of January 1977. Both the sexes participated in incubating the eggs, both of them working in shifts for a few hours during the day time, but only one of them would remain at the nest at night. Since one of them had lost several tail feathers it was possible to tell the otherwise indistinguishable members apart: it was always the one with the tail feathers intact that would take up the night duty. This individual, moreover, was also very aggressive as compared to the other. The feathers on its head were also conspicuous, in that they were always disturbed and slightly raised and would give an appearance of a comb. On two occasions when the bird was disturbed at night (because of my prying), the bird simply left the place leaving the nest unguarded all through the night only to return next day morning (after 11-00 a.m.) to see if the place was safe and undisturbed. Wallace and Mahan (1975) have reported that in Mourning Dove and some other columbids it is the female which takes on the duty of incubating the eggs at night, and is relieved by the male during the daytime. It is possible tha tthe aggressive individual doing the night shift is probably a female, and that the aggressive attitude towards suspected invaders develops during the breeding season rather than only during incubation periods; for, even after the young

ones had hatched out and had left the nest the aggressive attitude was maintained.

After continuous incubation of the eggs by both the parents, both the eggs hatched out on 13th February 1977, and the young ones left the nest together on the 27th. About five days later, a new nest was buit on the top of the existing one apparently by the same pair and an egg was laid on 6th March. However, the adult bird doing the night shift on the nest had an encounter with a prowling cat. The birds, subsequently abandoned the nest, which I ultimately cleared away.

A pair of doves moved in once again on 11th August 1977 and started nest building at the same site. The building activity was slow initially but became vigorous by 15th and continued with the same pace on 16th. The first egg was laid on 16th and the second on 17th. Both the young ones hatched out on 30th August. Soon after the nest-leaving by young ones on 12th September, the doves built one more nest on the top of the existing one and laid two eggs, one on 18th and the other on 19th of September. Two days later these were, however, found punctured—probably by a male House Sparrow which was always seen hovering near by.

Since the incubation period of the eggs is defined as the time interval between the laying of the last egg of the clutch and hatching of that egg (Welty 1964), the incubation period hitherto unreported in this species (Sálim Ali & Ripley 1969) could be said to be of 13-14 days.

DEPARTMENT OF ZOOLOGY,
FACULTY OF SCIENCE,
M. S. UNIVERSITY OF BARODA,
BARODA 390 002,
December 14, 1977.

R. V. NENE

REFERENCES

ALI, SALIM & RIPLEY, S. D. (1969): Handbook of the Birds of India and Pakistan, Vol. 3. Oxford University Press, Bombay.

WALLACE, G. J. & MAHAN, M. D. (1975): An introduction to Ornithology, 3rd edition. MacMillan Pub. Co., New York.

WELTY J. C. (1964): The life of Birds. Constable and Co. Ltd., London.

7. THE VOICE OF THE JUVENILE BROWN HAWK-OWL [*NINOX SCUTULATA* (RAFFLES)]

In a note on the calls of the Jungle Owlet (*Glaucidium radiatum*) (*J. Bombay nat. Hist. Soc. 68*: 830-2) I pointed out that the juvenile has a food-call quite unlike any of the numerous notes uttered by the adult. The juvenile Brown Hawk-Owl, too, has a set of call notes strikingly different from the adult's unvarying *oo-uk* or *oo-up* call.

Since the 26th of July, 1973, when, at Parambikulam, I heard the voice of a young Hawk-Owl for the first time, I have been hearing it in Trivandrum fairly regularly in June and July. However, it was only in 1977 that, apparently, our area fell within the territory of Hawk-Owl family. Between 4-vi-1977 and 27-x-1977 a juvenile and one parent used to

haunt our backyard. On 62 nights at least during these 5 months, the birds were in our area for periods varying from half an hour to two hours or more.

The young bird's favourite perch was the tip of a truncated, upward-pointing frond of a 40-foot coconut tree. Generally it used to sit there, calling from time to time, waiting for the parent to come and feed it.

The note most often uttered was a loud, rather querulous, nasal *kweng*. This would be repeated 2-6 times in 60-120 seconds, followed by 5-10 minutes of silence. Occasionally the young bird would be silent for as long as 30 minutes.

Variations such as a sharp *m-yóom, m-yóon, m-yóong, koom kyoom, kweyoong,* and a very brief *méwm* were often uttered, some of them highly suggestive of impatience and annoyance.

When the adult came, the young one used to utter a series of sharp, but low, *kwey-kwey-kweys,* but this was only in the earlier days. Later on, the only clue to feeding was the ghost-like form of the adult flitting to and away from the juvenile's perch. Throughout the period feeding was an absolutely silent and quick process. The adult in attendance never uttered any call-notes except towards the end of the period (September and October), when it appeared as though the juvenile was learning to produce the characteristic adult note. Elsewhere in the city the adult's voice could be heard frequently throughout this 5-month period as during other parts of the year.

After the 27th of October, 1977, the juvenile's peculiar call-note was never heard in our area. But on 1-i-1978 I heard it in another part of the city. My son, who is also very familiar with this call-note, wrote that he had heard it in December (1977) at Rourkela (Orissa). Therefore, it may be presumed that the juveniles of the two races, *N.s. lugubris* and *N.s. hirsuta* utter the same kind of food-calls.

I have made fairly satisfactory recordings of these notes on tape.

24/1337, Behind G.P.O.,
Trivandrum 695 001,
April 27, 1978.

K. K. NEELAKANTAN

8. NORTHWARD EXTENSION OF THE RANGE OF THE SOUTH INDIAN BLACK BULBUL *HYPSIPETES MADAGASCARIENSIS* SYKES

On 15th August 1977, Humayun Abdulali, J. S. Serrao the Society's Librarian, and the author, spent a delightful day motoring through some of the most wonderfully scenic country in north Thana District, not far from Bombay. We travelled along the Agra Road until Ghoti, where we branched off westwards, passed the Vaitarna Reservoir, and then through Khodala to Suriamal at the top of the Ghats turning south to Wada to rejoin the Agra Road at Bhiwandi.

Between Vaitarna and Suriamal, we saw a party of birds flying to a small mango by the road along the cultivated hillside. At first sight they looked like Blackheaded Blackbirds (*Turdus merula*). Through glasses we counted 11 birds moving about a tree—a flock of blackbirds!? Perplexed, we walked nearer and

as the birds flew across the road and settled again, we got excellent views of their slim grey bodies, scraggy blackcrested heads, orange-red bills and legs, and slightly forked tails—a flock of Black Bulbuls (*Hypsipetes madagascariensis ganeesa* Sykes)!

According to the books, the northernmost record is from Matheran. H.A. tells me that one was seen by Sálim Ali at Bhimashankar (on the main axis of the Sahyadri Range) on 8th September 1948, when they had visited the place together. He also noted a small party in a forest beat on the Pen-Khopoli road (east of Karnala) on 26th December 1965. Nesting records from Khandala by McCann and Navarro have been published (1945) (JBNHS 45:241) and it is common at Mahableshwar.

The present record extends the accepted range of the species northwards by approximately 90 km.

LAVKUMAR J. KHACHER[1]

WORLD WILDLIFE FUND—INDIA,
SHAHID BHAGAT SINGH ROAD,
BOMBAY 400 023,
August 25, 1977.

[1] *Present address*: 14 Jayant Society, Rajkot-4, Gujarat.

9. COURTSHIP SONG AND DISPLAY OF THE WHITETHROATED GROUND THRUSH *ZOOTHERA CITRINA CYANOTUS* (JARDINE & SELBY)

During the non-breeding months the Whitethroated Ground Thrush is quite frequently seen rummaging among the litter of the forest-floor, not much concerned about the presence of the birdwatcher. But a distinct change of mood occurs as the breeding season approaches. A bird may sometimes be seen singing from a bare high perch, but most often they become extremely shy and difficult to spot though the presence of numerous individuals evident from the rich lovely song which is a characteristic sound of a morning in April and May in the evergreen jungles of Mahableshwar, where most of my observations have been made. In high leafy or moss-covered branches of jambul the bird's chestnut and slate-blue coloration camouflages it surprisingly well. The voice has a ventriloquial quality which makes accurate location difficult, and the cautiously approaching birdwatcher usually sees the exasperatingly elusive and audience-shy songster only when it flies from its perch for a more private location to resume its serenade.

Singing from such well-concealed positions the male sometimes assumes its peculiar courtship display—probably the reason why the display is so seldom observed. I have been lucky enough to see it on a few occasions, invariably when the female was somewhere near. I give a composite description from the notes sent by me to Dr. Sálim Ali on these occasions.

The normally spruce upright-perching bird bows forward with wings drooping limply. The neck is stretched far forward horizontally

giving the bird a hunch-backed appearance and the head and beak point vertically down at right-angles to the horizontally stretched out neck. Seen from the rear the rufous on the sides of the bird is visible from behind the drooping wings as two small but conspicuous patches against the slaty grey back, slightly above each axilla. The overall effect in terms of human mime is a ludicrous abjectly humble shame-faced hanging head stance. The bird continues to sing during the display but the drollery is hightened when occasionally its full throated notes change to high-pitched scarcely audible pipings as if the serenader *was being choked by overpowering emotion.*

I first saw the display about 25 years ago one May morning at Matheran on the road between Coronation and Porcupine points. The bird was singing in a high crotch of a large tree—was very much puzzled when the bird suddenly went into the drooping wing pose. But when I saw the female fly in a couple of seconds later and settle near by, I realized that this was a courtship display by the male directed at her.

The next observation was made with Dr. Sálim Ali at Mahableshwar in April 1974. On a high jambul tree in a nallah between Jeejee Lodge and Dhun Villa what appeared to be a discoloured leaf was spotted by Dr. Sálim Ali as the male thrush in drooping pose. On 20.v.1976 I recorded another observation at Mahableshwar about 200 yards away from the foregoing location, again on a high jambul at the head of the path leading down to the nallah. The bird had been singing continuously for 10 minutes, before being spotted. The female about 25 ft up on a large horizontal branch appeared quite indifferent and was swallowing something small. The well-camouflaged displaying male was perched about 7 ft away and slightly higher in a thin leafy branch.

During the last observation (May 1977) at Mahableshwar on Dan to Beersheba path below Mt. Ferohin, I had an unusually clear and prolonged view of a singing and occasionally posing bird fairly low on a jambul branch. The pose varied from a scarcely noticeable droop to full intensity of contortion. The song also changed to the high pitched wheezing described previously, when the display was at its intensest. Possibly the change in pose and song varied according to the proximity of the female which unfortunately I could not spot in thick foliage till it flew away, the male first and the female following, when another thrush started singing about 30 yards away.

4-A, Rashmi,
Carmichael Road,
Bombay-400 026,
June 10, 1977.

DINSHA J. PANDAY

[Some more details of this bizarre display will be found on p. 88, Vol. 9, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, under the orange-headed (nominate) subspecies. That observation, however, was also made in Mahableshwar and should correctly refer to the Whitethroated Ground Thrush.—Eds.]

10. WAGTAILS AS PREDATORS OF FIELD BEAN APHIDS

Wagtails are essentially insectivorous birds preying on insects and other small arthropods. Toor and Ramzan (1975)[1] reported Wagtails as good predators of mustard aphid, *Lephaphis erysini* Kalt from Ludhiana.

We observed flocks of Wagtails feeding on the field bean aphid (*Aphis craccivora* Koch.) when we were screening the field bean germplasm to aphid resistance. The flock consisted mainly of the yellow Wagtail (*Motacilla flava* L.) and the Grey Wagtail (*Motacilla caspica* Gmelin). The field bean varieties (*Lablab niger* L.) were trained on to a pandal in about 20×15 sq. metre area, and the birds frequently visited the periphery of the plot. On detailed examination with 8×30 field glasses of the lowermost branches of the plant infested with aphids, it was ascertained that the birds fed on aphids. The birds also fed on aphide placed on a white paper kept on the ground near the plant, thus confirming the observation. Further, on close examination of the fed area, it was found that it had only the immature stages as compared to unfed areas where the aphid colony consisted of mature and immature forms, suggesting that the Wagtails fed mostly on adult and grown-up nymphs. Thus, it is inferred that the Wagtails play an important role in checking aphid build-up on field bean.

[1] TOOR, H. S. AND RAMZAN, M., (1975): The Grey Wagtail, *Motacilla caspica* Gmelin—a good predator of Mustard aphid, *Liphaphis erysini* Kalt. *Sci. & Cult., 41* (6): 288.

A. K. CHAKRAVARTHY
S. LINGAPPA

DEPARTMENT OF ENTOMOLOGY,
UNIVERSITY OF AGRIL. SCIENCES,
HEBBAL, BANGALORE-560 024,
April 29, 1978.

11. REACTION TO NIGHT SPOTTING IN THE GHARIAL, *GAVIALIS GANGETICUS* (GMELIN)

Light from a two-celled torch, held at the level of the eye, were thrown on captive hatchling and yearling gharials on various occasions. The eyes of all juveniles reflected a bright red glow when the yearlings were in water, they moved towards the light.

In line with gharial's body axis, the minimum distance from which the glow was perceived between 1.00 and 1.50 m for hatchlings about 50 cm long, and 1.75 and 2.00 m for yearlings over a metre. The glow could not be observed when the height of the light source was not lowered while nearing the animal. Because of obstructions the glow could not be seen beyond 6 m in experiments with both hatchlings and yearlings. However, reflections from juveniles, released in the wild in the Satkeshia Gorge of the River Mahanadi, have been percieved from a distance of about 15 m.

Observations made on captive muggers (*Crocodylus palustris*) also showed exactly similar results.

Abdulali (1951) reported that gharials do not reflect torch light, which was contradicted by Ross (1975). Ross (1975) further contradicted Oliver's (Abdulali 1957) statement that in gharial the colour of the glow is "much fainter".

Ross (1975) reported that "the eyes would not reflect light from a distance of less than 4 m" and that "this has also been observed for other species of crocodilians." However, the present observations on the captive gharials and muggers at the Gharial Research and Conservation Unit showed that the minimum distance for reflection of light by the eyes is 1.00 m for hatchlings about 50 cm long and 1.75 m for a metre long yearlings.

ACKNOWLEDGEMENTS

I am in receipt of a Research Fellowship from the Government of Orissa (Forest Department) through the State Crocodile Project. Thanks are due to Sri D. K. Sahoo and Sri I. C. Sahoo, Research Assistants for help.

GHARIAL RESEARCH AND CONSERVATION UNIT,
TIKERPADA 759122, ORISSA,
August 18, 1978.

LALA A. K. SINGH

REFERENCES

ABDULALI, H. (1957): Reflected glow from the eyes of the gharial *Gavialis gangeticus* (Gmelin). *J. Bombay nat. Hist. Soc. 54* (3): 769-770.

ROSS, C. A. (1975): Reflected glow from the eyes of the gharial *Gavialis gangeticus* (Gmelin) in captivity. *ibid. 72* (2): 557-558.

12. STRANGE PRACTICE OF A CATERPILLAR

Among the potted plants in the backyard of our house in Alipore area of Calcutta, I discovered one day by the middle of August, a caterpillar hidden within a broad leaf of a *Curcuma zedoaria rosa* (Zingiberaceae). The damaged leaf blade from which extensive areas had been eaten away drew my attention to it. I found a part of the broad leaf folded upon itself. When I pulled apart the leaf blade which was stuck with whitish silk webbings, a greenish grey, flat-looking caterpillar, about two inches long, came into view. The caterpillar had folded the leaf blade to make a chamber and remained snugly within it. It almost immediately started to fold the leaf back by secreting a sticky fluid from its mouth. It touched the leaf blade with its mouth alternately on its left and right side and stretched up a fine thread over its head. The thread soon grew thicker and that part of the leaf blade slowly but surely started to be folded upon itself. At this stage it suddenly started raining and the Curcuma leaf as well as the caterpillar got thoroughly drenched. But rain water did not seem to have any effect on the stickiness of the fluid or upon the determination of the caterpillar to continue its work.

While I was watching, I suddenly noticed slight contortions at the posterior end of the caterpillar where soon a blackish pellet came out. As I was closely watching, the caterpillar suddenly shot the pellet straight at me and hit me fully and squarely on the face. Perhaps it is normal for these caterpillars to eject their pellets of faeces in that way, but for a moment I had the feeling that the shooting had been done deliberately. As it was raining hard, and also as I had no desire to furnish the caterpillar with further targets, I withdrew from the scene rather in a huff.

Later in a cool moment, when I thought of the incident, it seemed to me that this remarkable habit of shooting of pellets of faeces by these caterpillars must have some useful purpose. These caterpillars can easily keep their chambers of folded leaves clean and unsoiled by shooting their faeces outside. And this shooting can also be used with telling effect upon their enemies which may try to sneak into the chamber from the rear.

After about twelve or fifteen days one morning at about 9 o'clock I found a medium big butterfly with white spotted black wings resting on the wall near that Curcuma plant. It was resting with its forewings upright and slightly apart and the hindwings resting flat, the white spots in the wings thus showing to advantage. It flew away when I tried to approach it. From the little that I could glimpse of the spotted wings and the sitting posture, I take it to be a Hesperiid. I wonder if this dapper and brisk butterfly could be the same dull and wormlike creature that behaved so disreputably with me a couple of weeks ago.

A. S. BHADURI

C/O. BAGCHI TRANSPORT COMPANY,
44 CHITTARANJAN AVENUE,
CALCUTTA 700 012,
September 4, 1978.

13. THE RED PIERROT *TALICADA NYSEUS* GUERIN (LEPIDOPTERA: LYCAENIDAE) IN BOMBAY AND THE SALSETTE ISLAND

Though 'Bombay', presumably the erstwhile Bombay Presidency or Bombay State prior to bifurcation into Gujarat and Maharashtra in May 1960, is listed under the range of the Red Pierrot, *Talicada nyseus* Guerin (Lycaenidae), there is neither a specific record of its occurrence in Bombay City and the Salsette Island in any of the lists published on the area in the *Journal* of the Bombay Natural History Society (Vols. 50 : 331-9; 53: 282-4; 54: 215-6; 56: 358-9; 57: 233-4; 74: 190-1), nor any specimen collected in the area is in the Society's collection. In these circumstances two specimens of the butterfly collected in the Bombay area in May 1979: one by Mr. P. W. Soman from Dadar, and the other by Miss Renée Borges from a garden in Colaba are of interest. These two specimens add to the Lepidopteran fauna of Bombay and Salsette Islands, and are now registered in the Society's collection.

Mr. J. S. Serrao of the Society informs me that this butterfly is rather common mostly during the dry season in gardens in Bandra, Bombay, and that it invariably keeps to patches of miscellaneous assortments of garden plants, with *Bryophyllum* interspersed here and there. He has also come across this butterfly in Mahableshwar in April/May 1978.

NARESH CHATURVEDI

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE, OPP. LION GATE,
SHAHID BHAGAT SINGH ROAD,
BOMBAY 400 023,
June 30, 1979.

14. ANTS (*CAMPONOTUS* SP.) HUNTING FLIES

On 20th June 1975, we observed an uncommon event. We were staying overnight at a tourist bungalow at the Borivli National Park, Bombay and while sitting on the verandah steps in the evening, we saw some black ants carrying flies. Every few seconds a new ant would appear with a lifeless fly. On tracking the line of ants, we discovered that the flies carried by the ants were not dead ones found by chance, but that the ants were systematically hunting flies. As the ground was moist and dirty, plenty of flies were hovering around, often landing and remaining on the ground for some time. The ants wandering about were pouncing on any fly within striking distance. Although the percentage of successful strikes was low, the frequency of strikes and the large number of ants ensured that every 30 seconds or so, at least one ant would get its prey. After striking and capturing the fly, the ant would bend into a 'U' so as to make its abdomen touch the fly. This was probably to inject some venom from its sting. After this the fly would stop struggling and would be carried off. Sometimes a fly was seen to escape the clutches of the ant, even after capture. The ants had their nest in a hole in the ground beside the wall of the house. There were two sizes of ants indulging in this hunting. One ant was observed to hunt in a different way. It would remain motionless in one place, (it was seen on a banana peel) and let the flies come near. Whenever a fly came too close, it would jump on it and try to catch it. This behaviour was observed on two separate days at the same place. Ants are known to hunt and kill other insects and even bigger animals are taken by army ants. But for an individual ant to hunt so agile a creature as a fly seemed unusual and uncommon. The flies were certainly in good health and perfectly capable of flying.

13/A, Avanti Apartments,
Sion (East),
Bombay-400 022,
February 2, 1979.

SHAILESH J. ZAVERI
JYOTINDRA J. ZAVERI
AMEET K. ZAVERI

15. COLOUR DURING LIFE OF THE CRAB *ATERGATIS ROSEUS* (RUPPELL)

The Xanthid walking crab *Atergatis roseus* (Ruppell) had been recorded by me, from collections made at Port Okha by my colleagues in the Department of Fisheries in the erstwhile Bombay State (Chhapgar, 1957, *JBNHS* 54, pages 426, 427). The crabs in that collection had been received by me preserved in formalin, and were seen to be of the colour of rose flowers; the trivial name *roseus* thus aptly describes the body coloration.

Subsequently I have had the opportunity to observe freshly collected crabs of this species; these had a brick-red body coloration quite similar to that of *Atergatis integerrimus* (Lamarck). However, while the latter has white pits on the carapace—sparsely distributed all over the outer hepatic, and the epi-, meso- and meta-branchial regions, the carapace in *A.*

roseus is uniformly brick-red except for an ivory-white border.

Incidentally, Alcock (1898, *Journ. Asiat. Soc. Bengal* 67, page 97), describing the coloration of *A. roseus* recorded from Madras and Karachi, gives it as "Colours in spirit brownish yellow." On the contrary, he has described the colours in spirit of *A. integerrimus* as "pinkish ochre."

E-31, Cusrow Baug,
Colaba Causeway,
Bombay-400 039,
March 15, 1979.

B. F. CHHAPGAR

16. NEW RECORDS OF EUPHORBIACEAE FROM MADHYA PRADESH

Among trees and shrubs enumerated by Biscoe (1910), 8 genera and 12 species of Euphorbiaceae were recorded from the erstwhile Indore State; while among weeds, Kenoyer (1924), reported 4 genera and 9 species of this family from the former princely state of Gwalior and adjacent parts. After reorganisation of states the floristic composition of Madhya Pradesh has been assessed and evaluated by Heweston (1951), Sagreiya and Singh (1958), Tiwari (1968) and Khan (1973).

Panigrahi and Prasad (1967) reported 23 genera and 47 species of Euphorbiaceae from Madhya Pradesh, while 14 genera and 27 species have been described by Kaushik (1969, 1974) from Shivpuri (M.P.). Recently a few more have been added by Oommachan (1973) and Javed (1975) from Bhopal, but none of these authors have included the following plants in their respective works.

(1) *Euphorbia microphylla* Heyne, (2) *E. trigona* How., (3) *Jatropha podagrica* Hook., (4) *Pedilanthus japonica* Hook., (5) *Phyllanthus nivosus* Bull and (6) *Synadenium grantii* Hook.

Thus these 6 species belonging to 5 different genera collected from Bhopal are new records from Madhya Pradesh as a whole.

Department of Botany,
Saifia College,
Bhopal (M.P.) 462 001,
September 23, 1976.

S. A. CHAGHTAI
ARUNA GARG

References

Biscoe, W. F. (1910): A List of Trees and Shrubs of the Indore State, Times Press, Bombay: 71-75.

Hewetson, C. E. (1951): Preparation of a Flora for Madhya Pradesh and Central Parts of Indian Union. *J. Bombay nat. Hist. Soc. 50*: 431-433.

Javed, A. (1975): A Study of the Medicinal Trees of Bhopal. M.Sc. Thesis. Bhopal University. (Unpublished).

Kaushik, J. P. (1969): A Contribution to the Flora of Shivpuri, Madhya Pradesh. *Bull. Bot. Survv. India.* II, (1 & 2): 51-69.

——————— (1974): Some Plants from Shivpuri District, Madhya Pradesh. *J. Jiwaji Univ.* II, (1): 58-64.

KENOYER, L. A. (1924): Weed Manual of Gwalior State and Adjacent Parts of India. Baptist Mission Press, Calcutta: 27-29.

KHAN, M. A. W. (1973): Madhya Pradesh Plants. Regional Press, Rewa (M.P.).

OOMMACHAN, M. (1973): Flora of Bhopal. Ph.D. Thesis, Vikram University, Ujjain (Unpublished).

PANIGRAHI, G. & PRASAD, R. (1967): Contribution to the Botany of Madhya Pradesh, IV (The family Euphorbiaceae and Urticaceae). *Proc. Nat. Acad. Sci. India, Sec.* B, 37 Pt. 4: 553-564

SAGREITYA, K. P. & SINGH, B. (1958): Botanical and Standardised Hindi names of Important and Common Forest Plants of Madhya Pradesh. Govt. Regional Press, Gwalior.

TIWARI, S .D. N. (1968): The Locations of Ornamental and useful Trees (Wild and Planted) in Madhya Pradesh. Govt. Regional Press, Rewa (M.P.): 42-44.

17. *ACALYPHA INDICA* LINN.—A NEW RECORD FOR GARHWAL

Many European botanists explored Garhwal from the end of eighteenth century to the beginning of twentieth century and their results were published by J. F. Duthie in 1906 in the revised Strachey and Winterbottom's "Catalogue of the Plants of Kumaon and of the adjacent portions of Garhwal and Tibet". In recent years Indian Workers who collected plants in this region make no mention of its occurrence.

Acalypha indica Linn. in Sp. Pl. 1003, 1753; Hook. f. in Fl. Brit, Ind. 5:416, 1887; Duthie in Fl. Upp. Gang. Pl. 3:108, 1920; Maheshwari in Fl. Delhi 316, 1963 & in Illustr. Fl. Delhi t. 197, 1966.

An erect annual herb, 30-80 cm. high with many spreading and ascending branches. Leaves membranous, 5 × 3.5 cm. Flowers minute, green in lax, erect, axillary spikes. Capsule glabrous.

G. S. Rajwar: 120 (30-9-1977) Kotdwara (Distt. Pauri). Common in waste places in dry situations. Flowering Aug.-May.

G. S. RAJWAR

DEPARTMENT OF BOTANY,
GOVT. POST GRADUATE COLLEGE,
KOTDWARA-246 149 (GARHWAL), U.P.,
May 20, 1978.

18. OCCURRENCE OF *MYRIOPHYLLUM SPICATUM* LINN. IN RAJASTHAN

Myriophyllum spicatum Linn. (Haloragaceae), a Himalayan plant, has so far been reported from Kashmir, northern boundary of Punjab and Uttar Pradesh between 500-2,000 m. above m.s.l. (Subramanyam, K.: Aquatic Angios. 17. 1962). During botanical exploration of Bikaner district, the senior author collected *M. spicatum* L. from stagnant water in the Rajasthan Canal near Lunkarnsar (240 m. above m.s.l.), where it grows in association with *Vallisneria spiralis* Linn. and *Potamogeton nodosus* Poir. or forms pure stands. It is interesting to note that this taxon has become fully adopted to adverse conditions. This species can be easily distinguished from other related taxa by its leaves being finely pinnated

into filiform segments. Spikes terminal; each flower in the axil of a large pinnatisect—serrate bract and two small, lateral, serrate bracts not exceeding 5 mm in length. Petals in male flowers only. Stamens 8. Fruits of 3, 1-seeded cocci which are tubercled on the dorso-lateral margins and muricated on its flat back. Furrows between the fruiting carpels are very narrow, hardly noticeable. *Flowering and Fruiting*: August-November.

The specimens (*Roy* 2160, 2424) are deposited in the herbarium of the Botanical Survey of India, Jodhpur (BSJO) and CNH., Howrah (CAL.).

BOTANICAL SURVEY OF INDIA,
D-7, SHASTRI NAGAR, JODHPUR,
RAJASTHAN.
November 1, 1977.

G. P. ROY
V. SINGH

19. RARE OR LITTLE KNOWN PLANTS FROM SOUTH INDIA

Five species of Angiosperms, known to be endemic to Kanyakumari and Tirunelveli Districts of Tamil Nadu and adjoining regions of Kerala, South India, are reported in this paper. They were rediscovered recently after a lapse of 70 to 100 years. All the specimens examined are present in MH.

Byrsophyllum tetrandrum (Bedd.) Hook. f. ex Bedd. Fl. Sylv. t. 326. 1873; Hook. f. Fl. Brit. India 3: 107. 1880; Bourd. For. Trees Travancore 217. 1908; Rao, Fl. Pl. Travancore 208. 1914; Gamble, Fl. Pres. Madras 2: 433. 1957 (repr. ed.). *Gardenia tetrandra* Bedd. Icon. t. 20. 1868-74. [RUBIACEAE].

Glabrous shrubs or small trees, 3-4.5 m tall; branches stout. Leaves 4.5-8 x 1.8-3.4 cm., elliptic-oblong to elliptic-obovate, entire coriaceous, shining, obtuse at apex, narrowed at base; petioles up to 2.5 cm long. Flowers up to 4 cm long, white reddish tinge without, fragrant; male in few—flowered terminal corymbs, female solitary or in pairs, terminal. Berries *c.* 2 cm across, ovoid or subglobose.

This species was described by Beddome during 1868-74, based on Captain Davidson's collection from "Travancore mountains (Athraymallay)". It was subsequently collected by Bourdillon from Muthukuzhivayal, Kanyakumari Dt. (previously S. Travancore, Kerala) in 1894. Recently we could relocate the plants in exposed areas at the top of the hill in Muthukuzhivayal area, and also in Agastyarmalai, Tirunelveli Dt., after a lapse of about 70 years.

Specimens examined: TAMIL NADU. Kanyakumari Dt.: M. K. Vayal, 4200 ft., 2-10-1894, *Bourdillon 371;* way to Muthukuzhivayal, 1000 m, 1-9-1976, *Henry 48190.* Tirunelveli Dt.: "S. Travencore & Tinnevelly", 5000 ft., *Beddome? s.n.* (acc. no. 25142); way to Agastyarmalai Peak, 1700 m, 1-7-1964, *Henry & Chandrabose 19219.*

Distribution: South India (Kanyakumari and Tirunelveli Dts. of Tamil Nadu, and adjoining regions of Kerala).

Didymocarpus missionis Wall. [Cat. no. 6396. 1832, *nomen*] ex R. Br. in Benn. & R. Br. Pl. Jav. Rar. 119. 1840; DC. Prodr. 9: 266. 1845; Clarke in DC. Mon. Phan. 5:104. 1883 & in Hook. f. Fl. Brit. India 4:354. 1884; Rao, Fl. Pl. Travancore 295. 1914; Gamble, Fl. Press. Madras 2: 694. 1957 (repr. ed.). *D. membranacea* Bedd. Icon. t. 176. 1868-74. [GESNERIACEAE].

Scapigerous, somewhat succulent herbs. Leaves up to 16 × 9 cm, ovate to ovate-lanceolate, succulent (appearing membranous in dried specimens), entire, pellucid white-hairy, acute at apex, cordate and unequal at base; petioles up to 13 cm long, white-hairy. Flowers 1.2-1.4 cm long, blue, funnel-shaped, in racemes on scapes up to 24 cm long. Capsules 3-4 cm long, slender, finely apiculate, glabrous.

Beddome (loc. cit.) who collected this species in 1874 remarks: "A most delicate species apparently very rare, I have only met with it in one place on the South Travancore ghats, moist rocks, Pachemallay (2000 feet elevation)". Gamble who could study both the Wallichian and Beddomean collections of this species at Kew Herbarium in 1922 writes on Beddome's sheet (acc. no. 36686, the only sheet present in MH): "Specimens badly wanted at Kew. The only one at Kew is in the Wallich collection....". After a lapse of over 100 years we could locate the plants on wet rocks in the ghats of Kanyakumari Dt., Tamil Nadu (old South Travancore).

Specimens examined: TAMIL NADU. Kanyakumari Dt.: Asamboo hills, Pachymallay, 2000 ft., *Beddome s.n.* (acc. no. 36686); Kalikesam riverside—Balamore, 700 m, 30-8-1976, *Henry 48151;* Kilaviarumalai—Balamore, 480 m, 28-7-1977, *Henry 49421.*

Distribution: South India (Kanyakumari Dt. of Tamil Nadu).

Didymocarpus ovalifolia Wight, Icon. t. 1351. 1848: Clarke in DC. Mon. Phan. 5: 104. 1883 & in Hook. f. Fl. Brit. India 4: 354. 1884; Rao, Fl. Pl. Travancore 295. 1914; Gamble, Fl. Pres. Madras 2: 694. 1957 (repr. ed.). [GESNERIACEAE].

Scapigerous, white—strigose herbs. Leaves up to 13 × 7.5 cm, elliptic—ovate, crenate—serrate, obtuse at apex, rounded at base; petioles up to 11.5 cm long. Flowers 1.5—2 cm long, bluish-violet, tubular-ventricose, 3-6, in umbels on scapes up to 19 cm long. Capsules 3-3.5 cm long, slender, cuspidate, pubescent.

Wight, who discovered this endemic species in 1848 (loc. cit.) writes under Explanation of plates: '!'Courtallam, flowering August and September. A very beautiful species conspicuous on account of the large size of its flowers." This species was subsequently collected by Beddome from Tirunelveli Hills in 1867. After a lapse of about 100 years, we could relocate this species along exposed rocky slopes at the top of Agastyarmalai Hills in Tirunelveli Dt. and in Muthukuzhivayal area, Kanyakumari Dt.

Specimens examined: TAMIL NADU. Kanyakumari Dt.: Muthukuzhivayal, 1300 m, 6-8-1977, *Henry 49610.* Tirunelveli Dt.: "Tinnevelly", 1867, *Beddome s.n.* (acc. no. 36737); "Tinnevelly hills", "Courtallam hills" *Beddome? s.n.* (acc. nos. 36687 & 36690); Exposed slopes-way to Agastyarmalai Peak, 1200 m, 24-8-1963, *Henry 17317;* Agastyarmalai Peak, 1600 m, 1-7-1964, *Henry & Chandrabose 19215.*

Distribution: South India (Kanyakumari and Tirunelveli Dts. of Tamil Nadu).

Elaeocarpus venustus Bedd. Fl. Sylv. t. 174. 1872; Bourd. For. Trees Travancore 60. 1908: Rao, Fl. Pl. Travancore 55. 1914; Gamble, Fl. Pres. Madras 1: 89. 1957 (repr. ed.). *E. monocera* sensu Masters in Hook. f. Fl. Brit. India 1: 405. 1874. *p.p.* (non Cav.). [ELAEOCARPACEAE].

Trees. 12-15 m tall; branches glabrous. Leaves 6-12 × 3-5 cm elliptic or obovate, inconspicuously serrate-apiculate, glabrous, acute at apex, attenuate at base; the axils of primary nerves beneath with large glands promi-

nently impressed above; petioles 1-3 cm long. Flowers 2.5-3 cm across, white, in axillary, 4-8—flowered racemes: pedicels 2-2.5 cm long. Sepals glabrous without, pubescent within. Petals fimbriate, silky without and at base within. Anthers minutely puberulous, mucronate. "Drupe ovoid, about 2 in. by 1 in., hanging on 2-3 in. peduncles from the old wood" (Bourdillon).

Beddome (loc. cit.) who described this species states: "A fine large tree only observed in the Muti-kuli vayal...it is truly beautiful when covered with its snow white large flowers, which it produces in great abundance ..." This endemic species was subsequently reported by Bourdillon (loc. cit.) from "Muthu kuli vayal and Chimunji in South Travancore at an elevation of 3500—4500 ft." After a lapse of over seventy years, we have succeeded in locating this rare plant again at the type locality, and making its first representation in MH.

Specimens examined: TAMIL NADU. Kanyakumari Dt.: Muthukuzhivayal, 1400 m, 10-9-1976, *Henry 48327;* Oothu to Upper Kodayar, 1300 m, 8-8-1977, *Henry 49662.*

Distribution: South India (Kanyakumari Dt. of Tamil Nadu and adjoining regions of Kerala).

Eugenia floccosa Bedd. Fl. Sylv. t. 200. 1872; Duthie in Hook. f. Fl. Brit. India 2: 501. 1879; Rao, Fl. Pl. Travancore 170. 1914; Gamble, Fl. Pres. Madras 1: 342. 1957 (repr. ed.). [MYRTACEAE].

Trees, 8-12 m tall, young parts densely floccose. Leaves 4-14 × 2-7.5 cm, broadly elliptic or obovate, entire, densely floccose on both sides when young, glabrescent when old, rounded or obtuse at apex, obtuse at base, nerves not prominent, arched, midrib impressed below, petioles 1-2 cm long. Flowers 2.3-2.6 cm across, showy, few in cymes, or solitary; corolla 2 cm long, white, floccose without, glabrous within, larger than calyx. Berries 3.5-4 cm across, globose, densely floccose, crowned with large persistent calyx-lobes.

"This is a most beautiful tree" (Beddome), scattered along outskirts of shola forests. Beddome, who described the size of the fruit as that of a Pigeon's egg, apparently observed only young fruits. Later workers accepted Beddome's description, as they evidently could not study additional materials. After a lapse of a century, we have located this plant in the vicinity of the type locality—"above calcad", in both flowers and fruits. The fruit at maturity is quite large, about 4 cm across.

Merril & Perry (Jorun. Arn. Arb. 18 : 322-343. 1937 & seq.) opine that majority of the Old World species of *Eugenia* should be placed under *Syzygium* Gaertn. Their arguments for separating *Syzygium* from *Eugenia* are based mainly on the structure of seed: *Syzygium* has the cotyledons separate and distinct while in *Eugenia* (sensu stricto) they are fused together and are mechanically inseparable; further the testa in *Syzygium* is adherent to the pericarp while in true *Eugenia* it is free from it and adherent to the cotyledons. Henderson (Garden. Bull. Singapore 12: 1-293. 1949), while revising the genus *Eugenia* in Malaya has shown that the seed coat and its degree of adherence to the cotyledons, and the pseudomonocotyledonous nature of the seed, could hardly be used as a basis for generic distinctions. For the present we treat this species under *Eugenia* Linn. (sensu lato) since a complete monograph on the subject is not available.

Specimens examined: TAMIL NADU. Kanyakumari Dt.: Muthukuzhivayal, 1400 m, 10-9-1976, *Henry 48320* & 6-8-1977, *Henry*

49618. Tirunelveli Dt.: Calcad hills, *Beddome? s.n.* (acc. no. 20811); Tinnevelly, *Beddome s.n.* (sec. nos. 20812-14 & 85664); Oothu, 1-9-1963, *Henry 17410*.

Distribution: South India (Kanyakumari & Tirunelveli Dts. of Tamil Nadu).

ACKNOWLEDGEMENT

We are thankful to Dr. N. C. Nair, Deputy Director, Botanical Survey of India, Southern Circle, Coimbatore for facilities and encouragement.

BOTANICAL SURVEY OF INDIA,
SOUTHERN CIRCLE, COIMBATORE,
October 25, 1977.

A. N. HENRY
M. S. SWAMINATHAN

20. NOTES ON THE DISTRIBUTION OF A FEW INDIAN GRASSES

Hitherto *Indochloa clarkii* (Hack.) Bor, (Panicoideae-Andropogoneae) was considered to be endemic in the Pareshnath hills, Bihar. The present paper reports its occurrence on the plateau of Madhya Pradesh for the first time. This shows that it is a rare grass but not with a restricted distribution.

Indochloa clarkii (Hack.) Bor in Kew Bull. 1954: 76, 1954.

(Panicoideae—Andropogoneae, Poaceae)

Hooker (Flora of British India 7: 197. 1897) recorded this taxon under *Andropogon clarkii* Hack. and Haines (Bot. Bihar & Orissa 1040. 1924) placed it under *Dicanthium clarkii* (Hack.) Haines. Both the authors reported the species from the top of Pareshnath hill. This report from Sonmuda, Bilaspur, Madhya Pradesh, 5-11-1970, *G. Panigrahi* 13333 (BSA), is an extension of the range of the species northwards.

As such it appears to extend its range under favourable environments into the adjoining hilly regions. The Collector records: "rooting in black mud along Son River stream. A large number of branches from lower internodes. Inflorescence with chocolate coloured awns. Seen only here. Very light grass. Rare." However, examinations of the available materials in (CAL) reveal: that the glabrous stems, leaves glabrous, except the margin, young leaves, matured pedicels and neuter spikelets, reddish brown, and fertile ones villose, help to identify the taxon in the field.

Polypogon monspeliensis (Linn.) Desf. (Poaideae-Agrostideae)—This grass has been known for a long time from North Western Himalayas, the Upper Gangetic Plains, Bihar and Madras as a winter annual. The winter in the Upper Gangetic Plains is very severe. Grows as a bushy grass in low lying marshy lands at different localities of Howrah district in West Bengal. It appears that this grass has successfully invaded the Lower Gangetic Plains of India at its eastern most extension.

Polypogon monspeliensis (Linn.) Desf. Fl. Allant. 1: 64. 1789.—*Alopecurus monospeliensis* Linn. Sp. Pl. ed. 1, 61. 1753. Tufted annuals. Panicles spiciform oblong or cylindric; glumes oblong, scaberulous ciliolate, tip deeply notched; awn from the sinus or beneath it, 5-9.8 mm long, 2-3 times the length of the glumes.

INDIA: West Bengal, Howrah district. Thanamakua, *A. K. Naskar* s.n., collected on 12-8-72 (*CAL*): Andul Road, West Bengal, Near Damodar Valley Corp., Feb. '72,

Growing on moist situations, *R. B. Mazumdar* 1; 2, 3 (*CAL*)

Rhynchelytrum villosum (Parl.) Chiov. in Ann. 1st Bot. Roma 8: 310, 1908, (Panicoideae—Paniceae, Poaceae). This grass is reported here from West Bengal for the first time. During the identification of earlier collection, we located specimens collected from the slope facing the river Hooghly, IBG Head Office Ghat, (Opp. to old herbarium building), Indian Botanic Graden, Howrah (*H. P. Naskar* 1 on 15-3-1949,: *CAL*). It is an erect herb with scabrid leaf sheaths; pedicels of the spikelets not hairy. Glume I, linear-oblong, obtuse, minute. Glume IV thin, 0.8 mm, below the upper, bearded at the base, glabrescent upwards. It occurs on sandy loam soil. A scrutiny of available literature as well as herbarium specimens in the Central National Herbarium, Howrah, (CAL), revealed that this species has been collected from Badami also (*A. Meebold* 11215, Sept. 1910, *CAL*) The range of the species extends to Tropical Africa. Bor (Grasses of India, Burma & Ceylon: 355, 1960) reports it from Punjab and Rajputana. Thus the present report establishes the continuity of the distribution from Northwestern and Peninsular India.

We are indebted to the Director, Botanical Survey of India, for all facilities and thankful to Dr. R. B. Majumdar, Regional Botanist, Eastern Circle (ASSAM) for his guidance.

BARIN GHOSH
R. N. BANERJEE

BOTANICAL SURVEY OF INDIA,
HOWRAH-3.
November 5, 1977.

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater, 4th edition (reprint). 28 plates in colour by Paul Barruel and many other monochrome illustrations. (*in Press*)

The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett. Rs. 10

Birds

The Book of Indian Birds, by Sálim Ali. 11th (revised) edition. 74 coloured and many monochrome plates. (*in Press*)

Checklist of the Birds of Maharashtra, by Humayun Abdulali. Rs. 2.50
(*Price to members Rs.* 2)

Checklist of the Birds of Delhi, Agra and Bharatpur, by Humayun Abdulali & J. D. Panday. Rs. 3.00

Snakes

Identification of Poisonous Snakes, Wall chart in Gujarati, and Marathi. Rs. 5

Plants

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 3rd edition (Reprint). Rs. 40.00
(*Price to members Rs.* 35)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. 2nd edition. (*in Press*)

Miscellaneous

Glimpses of Nature Series Booklets:

1. Our Birds I (with 8 coloured plates) in Kannada Rs. 0.62
2. Our Beautiful Trees (with 8 coloured plates) in Hindi Rs. 0.62
3. Our Monsoon Plants (with 8 coloured plates) in Gujarati, Hindi and Marathi. Rs. 0.80
4. Our Animals (with 8 coloured plates) in English, Gujarati, Hindi and Marathi Rs. 1.25

Glimpses of Nature in India (with 40 coloured plates) in English Rs. 7.50
(*Price to members Rs.* 5)

Back numbers of the Society's Journal. Rates on application.

The Society will gratefully accept back numbers of the *Journal*, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Entrance Fees:

Ordinary and Life Members ..	Rs. 25
Student Members ..	Rs. 10

Subscription:

(*a*) Ordinary individual Members ..	Rs. 50
(*b*) Ordinary Corporate Members ..	Rs. 100
(*c*) Ordinary Members resident outside India ..	Rs. 85
Life Members ..	Rs. 750 (Rs. 250 after 20 years)
Compound Corporate Members ..	Rs. 1500
Student Members (without Journal) ..	Rs. 10
Annual subscription to Journal ..	Rs. 105

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £ 5.50 should be paid annually to the Society's London Bankers—The Grindlays Bank Ltd., 23 Fenchurch Street, London EC3P. 3ED. Account No. 1101091.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

CONTENTS

Printed by Bro. Leo at St. Francis Industrial Training Institute, Borivli, Bombay 400 092 and published by Editors: J. C. Daniel, P. V. Bole and A. N. D. Nanavati for Bombay Natural History Society, Hornbill House, Shahid Bhagat Singh Road, Bombay 400 023.

JOURNAL

of the Bombay Natural History Society

Vol. 76, No. 3

Editors : J. C. Daniel, P. V. Bole & A. N. D. Nanavati

DECEMBER 1979 Rs. 35

NOTICE TO CONTRIBUTORS

Contributors of scientific articles are requested to assist the editors by observing the following instructions:

1. Papers which have at the same time been offered for publication to other journals or periodicals, or have already been published elsewhere, should not be submitted.

2. The MS. should be typed (double spacing) on one side of a sheet only, and the sheets properly numbered.

3. All scientific names to be printed in italics should be underlined.

4. Trinomials referring to subspecies should only be used where identification has been authentically established by comparison of specimens actually collected.

5. Photographs for reproduction must be clear and show good contrast. Prints must be of a size not smaller than 8.20 × 5.60 cm (No. 2 Brownie) and on glossy glazed paper.

6. Text-figures, line drawings, and maps should be in Indian ink, preferably on Bristol board.

7. References to literature should be placed at the end of the paper, alphabetically arranged under author's name, with the abridged titles of journals or periodicals underlined (italics) and titles of books *not* underlined (roman type), thus:

Banerji, M. L. (1958): Botanical Exploration in East Nepal. *J. Bombay nat. Hist. Soc.* *55*(2):243-268.

Prater, S. H. (1948): The Book of Indian Animals. Bombay. Titles of papers should not be underlined.

8. Reference to literature in the text should be made by quoting the author's name and year of publication, thus: (Banerji 1958).

9. *Synopsis*: Each scientific paper should be accompanied by a concise, clearly written synopsis, normally not exceeding 200 words.

10. *Reprints*: Authors are supplied 25 reprints of their articles free of charge. In the case of joint authorship, 50 copies will be given gratis to be distributed among the two or more authors. Orders for additional reprints should be in multiples of 25 and should be received within two weeks after the author is informed of the acceptance of the manuscript. They will be charged for at cost plus postage and packing.

11. The editors reserve the right, other things being equal, to publish a member's contribution earlier than a non-member's.

Hornbill House,
Shahid Bhagat Singh Road,
Bombay 400 023.

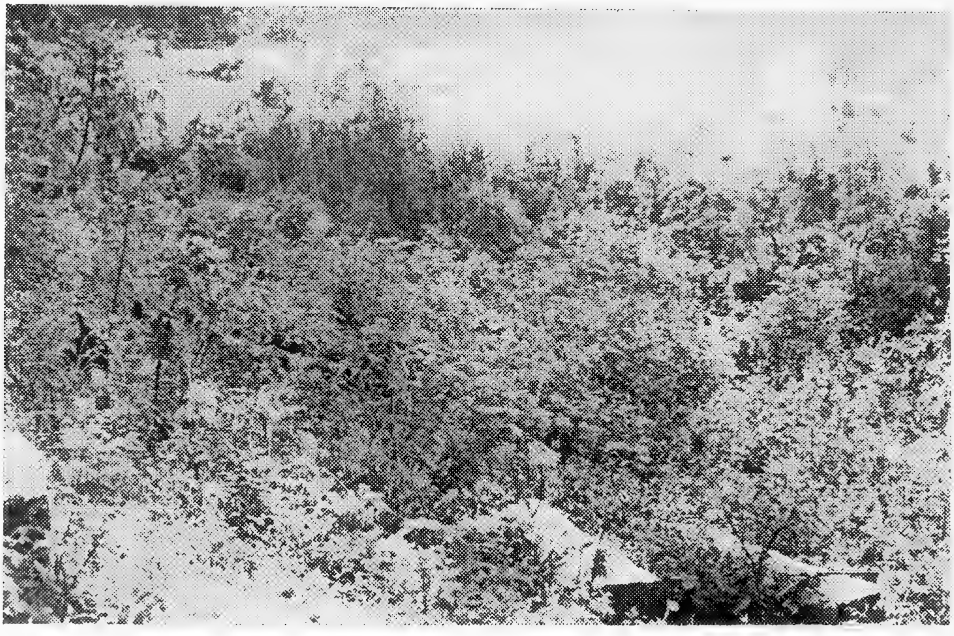
EDITORS,
Journal of the Bombay Natural History Society.

VOLUME 76(3): DECEMBER 1979

Date of Publication: 18-8-1980

PAGE

CONTENTS



Above: A view of secondary growth study area in the foreground, with mature forest on the hill slope in the background. *Below*: A closer view of part of the secondary growth area, with agricultural land in the background.

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1979 DECEMBER Vol. 76 No. 3

THE SEASONALITY AND OCCURRENCE OF BIRDS IN THE EASTERN GHATS OF ANDHRA PRADESH[1]

Trevor D. Price[2]

(*With a plate and thirteen text-figures*)

It is well known that seasonal climates have a marked effect on the annual cycle of birds. In the tropics, seasonality in rainfall has been shown to affect birds' annual cycles in Sarawak (Fogden 1972) and Panama (Karr 1976a) through an effect on the food supply. I spent one year from August 23rd 1976 until August 2nd 1977 in the Eastern Ghats of Andhra Pradesh, India, mainly at one locality, (the village of Lammasinghi) and visited again in 1978 from January 5th to February 10th. The intention was to document the seasonal occurrence of bird species and seasonality in the resident species, and relate this to the food supply. This was primarily an over-Winter investigation and attention was paid to the appearance and possible impact of Palaearctic migrants, which is poorly understood (Chipley 1976), particularly in India (Karr 1976b).

[1] Accepted February 1979.

[2]Division of Biological Sciences, Natural Science Building, Ann Arbor, Michigan 48109, U.S.A.

Whistler and Kinnear (1932) in the introduction to their pioneering report on the avifauna of the Eastern Ghats of India remarked that the area was ornithologically the least known in India. Their report did much to rectify the situation at that time, but since then little more information has been added (for a notable exception see Abdulali 1945, 1953), so that once again the area, particularly the Ghats in Andhra Pradesh and Orissa is comparatively poorly known.

Besides the intrinsic interest in having complete and detailed species lists for any area, there are at least two reasons why it is important to increase our knowledge of bird life in the Eastern Ghats. The first is that much of the natural forest is being rapidly removed for agriculture and monoculture plantations. This is having a profound effect on species diversity (Ripley 1979) and needs to be documented. The second concerns the controversy over the presence of Himalayan species in peninsular mountain ranges. Hora (1949) sug-

gested that the Satpuras had provided an important migration route to the mountains of south west India, while Abdulali (1949) thought that the Eastern Ghats route may have been equally important. Modern island biogeography theory (MacArthur and Wilson 1967) hypothesizes that each mountain range has relict species "stranded" after climatic amelioration, and makes interesting predictions about the numbers of species in relation to highland area. India is the ideal place to test these predictions.

Locality, climate and study area

Lammasinghi (altitude c. 850 metres) is situated on a watershed in the south east edge of the Eastern Ghats (figure 1). To the east there is a steep drop to the 65 kilometre wide coastal plain. To the north and south hills rise a further 300 metres, and to the west stretches the Chintapalli plateau, much of it deforested for cultivation although mature forest remains on many of the hillsides rising from the plateau, and on the ghatface itself. The forest type at Lammasinghi is tropical moist deciduous (see below). Other habitats in the vicinity include moist semi-evergreen forest (notably in the Gudem-Merripakala area); dry deciduous forest and open grassland on mountain tops; perennially cultivated wetlands at higher altitudes (for example around Solabum) and the cultivated, moist, coastal plain. Champion and Seth (1968) describe the forest types in detail.

The climate is highly seasonal, with three seasons recognised. 1) A monsoon season from June to September when most of the rainfalls and storms may be violent. 2) A winter season from October to February—temperatures may fall below 10°C, rain is very rare and thick fogs persist up to three hours from dawn. 3)

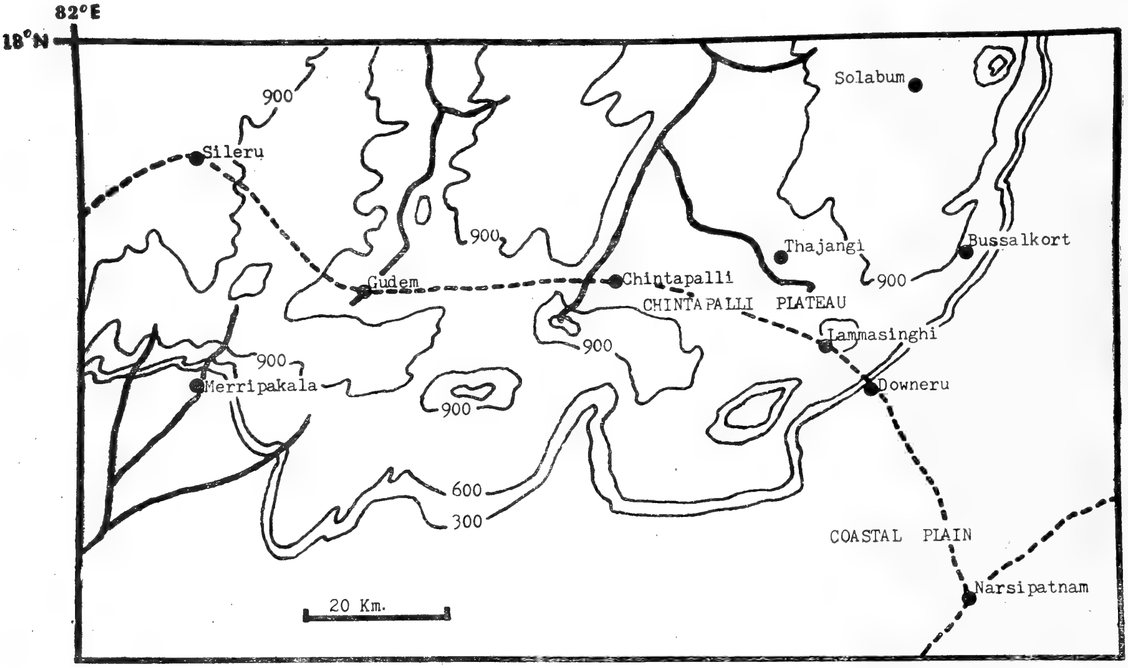


Fig. 1. Map of the Chintapalli Plateau showing villages mentioned in the text, roads (dotted), rivers, and contour lines at 300 metre intervals.

A Spring season from March to May—characterised by increasing amounts of rainfall, especially as convection storms in the afternoon; it can also be dry and hot with maximum temperatures (up to 40°C) recorded at this time of year.

Figure 2 gives available data on total rainfall for two extreme years, and figure 3 shows the number of rainy days per week and mean weekly temperatures, taken daily at 0500 and 1300 during the main study period (1976-1977). Qualitatively 1976 was atypically dry so that the area was very desiccated during the 1976-1977 Winter, while 1977 was exceptionally wet (due to unusually heavy rainfall in April, May and November), and the area much more moist during the 1977-1978 Winter.

Two study areas were set up, about 1½ kilometres apart in adjacent habitats. The first, on a hillside was under mature forest. This forest is characterised by straight boled tree species and a canopy at 13-23 metres. 114 trees were enumerated along a transect line. They grouped into 30 species with *Grewia tiliaefolia*, *Schleichera oleosa* and *Pterocarpus*

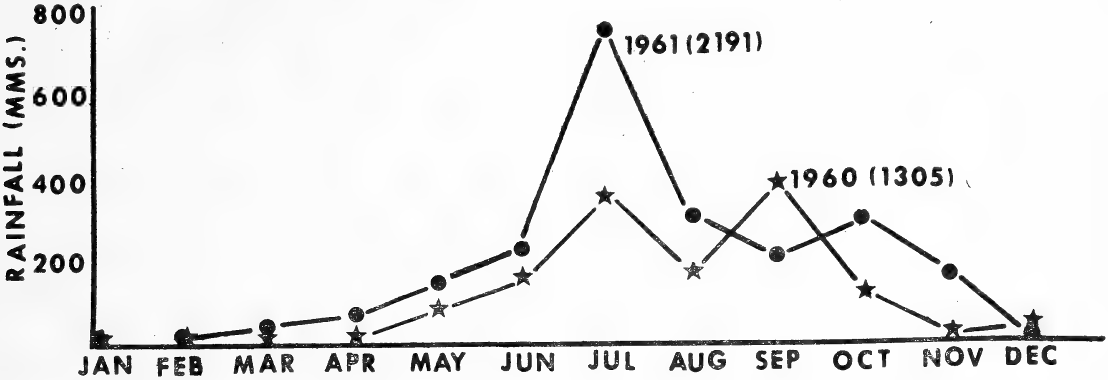


Fig. 2. Monthly rainfall for the years 1960 and 1961. Total rainfall (in mm) for each year is given in parentheses.

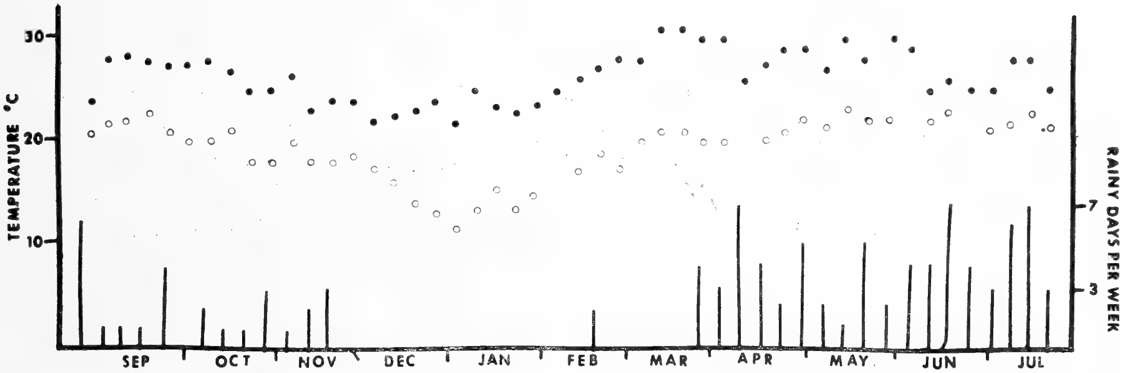


Fig. 3. Temperature and rainfall data during the 1976-1977 study period. Dots represent mean weekly temperature at 1300 hours, open circles mean weekly temperature at 0500 hours, and the histogram the number of days with rain each week.

marsupium dominant. The understory is poorly developed and regularly burnt through towards the end of the dry season (March-April).

The second (="main") study area was in secondary growth below the hill, which although desiccating considerably during the dry season remains wetter than the hillside, and such trees as *Ficus tsiela* and *Mangifera indica* are found. Some trees have been selectively retained in the square kilometre study area: 114 of 38 species were identified with *Syzygium cuminii* and *Mangifera indica* dominant. Bushes (e.g. *Lantana camara*), shrubs, and regenerating trees grow up to seven metres high, although there are open spaces maintained by heavy grazing and firewood collecting. In addition there are fields cultivated during the monsoon interspersed and some paddy lands along a small stream. In both study areas *Bombax ceiba* occurs and is important as a nectar source for birds in February and March (see plate).

Methods

During the main study period (August 1976 to August 1977) I was away from the site for more than three days on just two occasions; from December 2nd to December 9th and June 2nd to June 12th. Unless the year is included all dates refer to this period.

I also use the results from two bird ringing camps organised by the Bombay Natural History Society from March to May in 1971 and 1972. The methods used in these studies were different from those I employed; many more mist nets being spread over a much wider area.

Several routine sampling operations were carried out to assess Arthropod and bird abundance. Arthropods were sampled in a number of ways. In the mature forest only a single sampling method was employed—a branch (between six and eight metres long) of a single tree (a *Terminalia tomentosa*) was cut at approximately two month intervals and all insects remaining after it had fallen to a ground sheet below were collected. In the secondary growth area the following methods were used: (1) A weekly half hour search of a vegetation stand was conducted, aspirating all observed Arthropods able to pass down the four mm. diameter tube. (2) Two white bowls ("water traps") containing a detergent-water mix into which insects fly were left at standard locations for 48 hours each week. (3) Two jars were sunk in the ground (pitfall traps) and emptied every two weeks. (4) Every three weeks 300 sweeps with a sweep net were made through another secondary growth area. All insects were sorted by Order and into four size classes at the Department of Zoology, Andhra University, Waltair.

Birds were sampled in two ways—through direct observation and mist netting. Each week mist nets were placed in standard sites from just above ground level to approximately two metres high. Ten nets (158 metres total length) were regularly placed in half of the secondary growth area and kept open from 1600 hours on one day until dusk the next. On another day in the week eight nets (125 metres) were placed in the other half of the secondary growth area and kept open from dawn to dusk. From the middle of March extensive clearing by nomadic tribes necessitated the amalgamation of these two days into an evening and one full day (13 nets, 211 metres). Eight nets (132 metres) were routinely placed under the forest canopy, in the second study area, although this trapping session was omitted on about six occasions through the year. Occasionally nets were placed out of the main study area in order to examine bird movements or occurrences in different habitats.

All trapped birds were weighed (to the nearest 0.1 gram if under 30 grams weight, the nearest 0.5 gram if over this weight), measured (wing length in mm), examined for state of moult and breeding, and released. Many were recaptured up to a maximum of twelve times.

Observation was conducted concordantly with the trapping, and confined almost entirely to the vicinity of the study areas. All birds recorded were entered in a daily log book. Although the intensity of coverage varied from day to day and month to month, it is felt that the average daily coverage for each month was approximately constant. A five kilometre walk, spread over three days was conducted shortly after dawn each week, recording all bird calls heard, when they could be identified. A general impression of diets was obtained through direct observation and microscopic examination of faeces collected during trapping operations.

About eight weekends were spent away from the study area visiting villages named on the map (Figure 1), in an attempt to put the occurrence of birds at Lammasinghi in a clearer context. The village of Thajangi, seven kilometres away, at which there is a new reservoir surrounded by agricultural land, was visited about nine times during the year.

RESULTS

Arthropod abundance

The deciduous forest undergoes leaf drop steadily through the dry season. A qualitative impression of leaf cover changes in the ma-

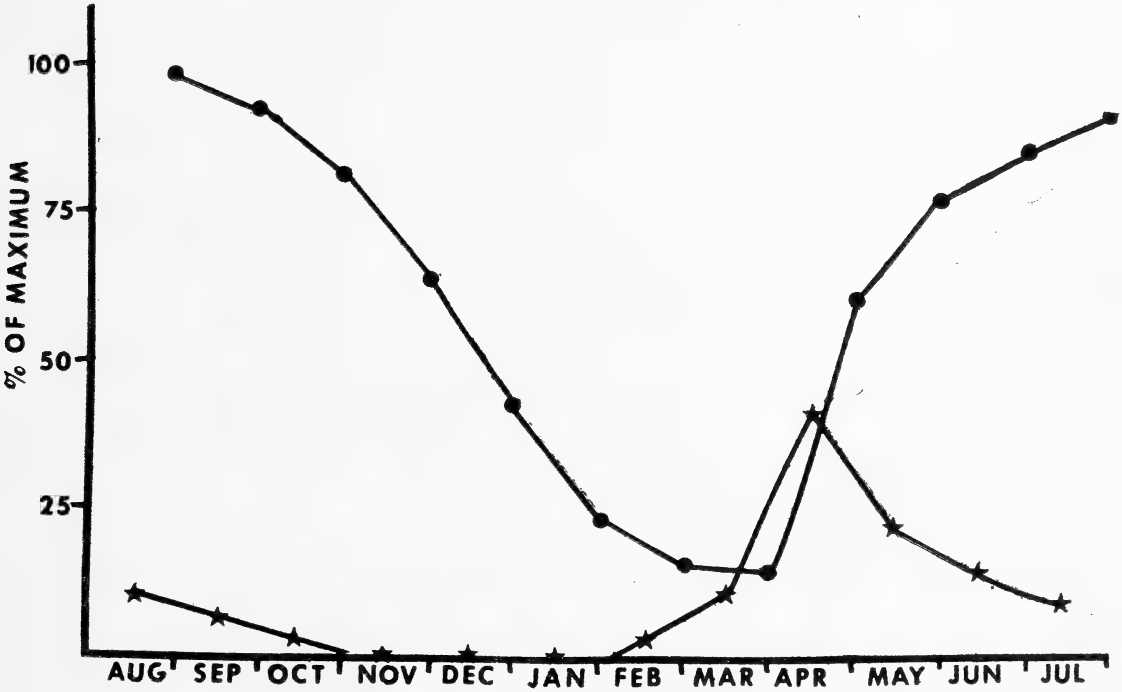


Fig. 4. A qualitative impression of leaf cover and leaf growth in the mature forest. Dots represent total leaf cover as a percentage of maximum; stars the proportion of new leaf growth in any one month.

ture forest was obtained through monthly photography and routine description of certain trees, and is presented in Figure 4. In 1977 minimal leaf cover was attained in mid March, although by then several trees had come into new leaf. Some species (e.g. *Ficus* spp., *Mangifera indica*) are evergreen; other species have an extended leafless period (e.g. *Bombax ceiba*), while most species (e.g. *Syzygium cuminii*) overlap loss of leaf with that of new leaf growth. The extent of the overlap depends on the tree species, the previous season's rainfall, and the site of the tree particularly with regard to aspect and drainage. Fluctuations in total leaf cover are considerably less in the secondary growth area and forest understory than in the mature forest canopy.

insect abundance in areas with an extended dry season concurrent with leaf loss, and in particular with lack of new leaf growth (Fogden 1972, Janzen 1973, Karr 1976a). Janzen (1973), for instance, noted a 90% decrease in Arthropod biomass through the dry season in Costa Rica.

In the secondary growth, sweep netting results (Figure 6) show an early dry season increase. Janzen (1973) noted a similar increase in Costa Rica and attributed it to migration from the more rapidly drying out forest canopy. Support for the migration hypothesis in this study comes from the observation that a large proportion of the increase was due to Diptera (Figure 6). The results from other collecting methods are detailed in Figure 7. All collection methods show significant increases

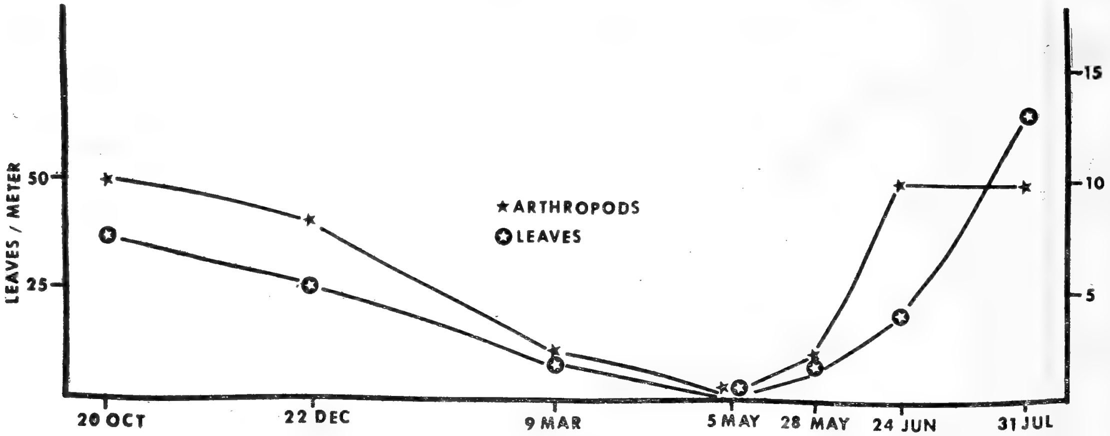


Fig. 5. Arthropods per metre and leaves per metre on individual branches cut from a *Terminalia tomentosa* tree through 1976-1977.

The number of Arthropods on the cut branch from the *Terminalia tomentosa* tree (which is one of the last tree species to lose and gain leaf in the season) correlates significantly with the number of leaves (Figure 5, $r = 0.756$, $°F = 5$, $p < 0.05$). Other studies in the tropics have demonstrated a decrease in

in Arthropod numbers in April-May over the February-March numbers. There are biases in all collecting methods (Southwood 1966), due, among other reasons, to the variable influence of weather conditions, the inability to correct for changing leaf density, and patchiness in distribution of insects (pers. dos.). Two

further caveats suggest that wet season abundances may be relatively greater than the figures imply. The first is that the sampling is confined almost entirely to the secondary growth area, where fluctuations may be dampened with respect to the mature forest, and the observations confounded by migration. The second applies to my own inexperience in aspirating and sweep netting early in the study.

In summary, Arthropod abundance decreases continuously through the dry season, beginning to increase with late dry season flower and leaf growth, and in particular with the tremendous growth of new leaf towards the end of April, to high levels during the monsoon season. Some Arthropods [e.g. millipedes (Diplopoda), cicadas (Homoptera) and large beetles (Coleoptera) (Figure 7: pitfalls)] disappear during the dry season, whereas the abundance of some other groups (e.g. some Hymenoptera) apparently remains relatively constant through the year.

Bird abundance

119 species were trapped in mist nets (table 1) and a further 35 observed in the immediate vicinity (this latter figure falls short of the true number because many of the larger non-passerines—especially birds of prey—went unidentified and are not included). A complete species list is detailed after the discussion,

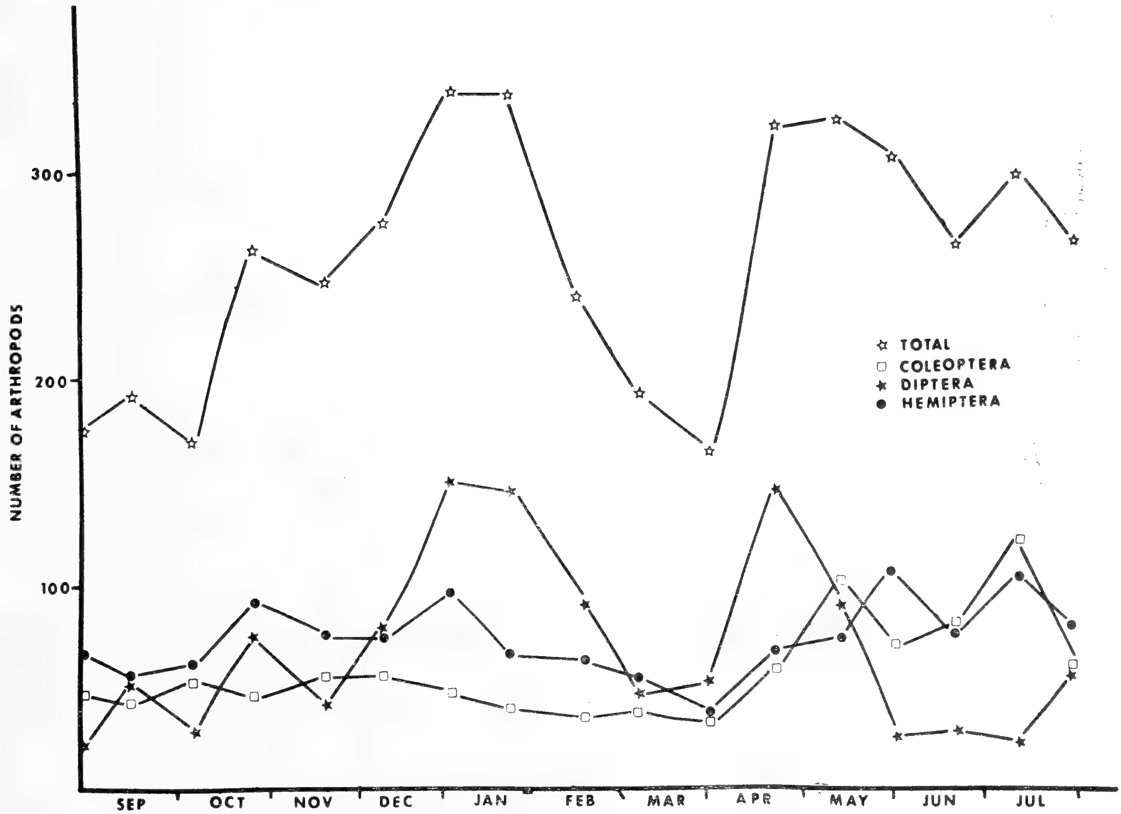


Fig. 6. Numbers of Arthropods collected in regular 300 sweeps through a stand of vegetation in the secondary growth area.

where scientific names are given.

There were 47 'standard' trapping weeks and 221 days of observation during the 1976-1977 study period. The total catch per week, grouped into three week periods, is plotted in Figure 8. The catch remains approximately constant despite changes in species composition until May, when it drops as species become more arboreal and sedentary (post-breeding—see below). Deterioration in the capture rate may also be due to birds learning to avoid nets (see, for example, Nisbet and Medway. 1972).

The quality of the observational records increased as I became familiar with the birds and is difficult to quantify. It took up to four months to become acquainted with some of the call notes so, with the exception of the long tailed nightjar, analysis is restricted to observation only. The percentage of total days observation on which at least one individual of a given species was observed is given in table 1. There is a good correlation with the total number of individuals captured in the

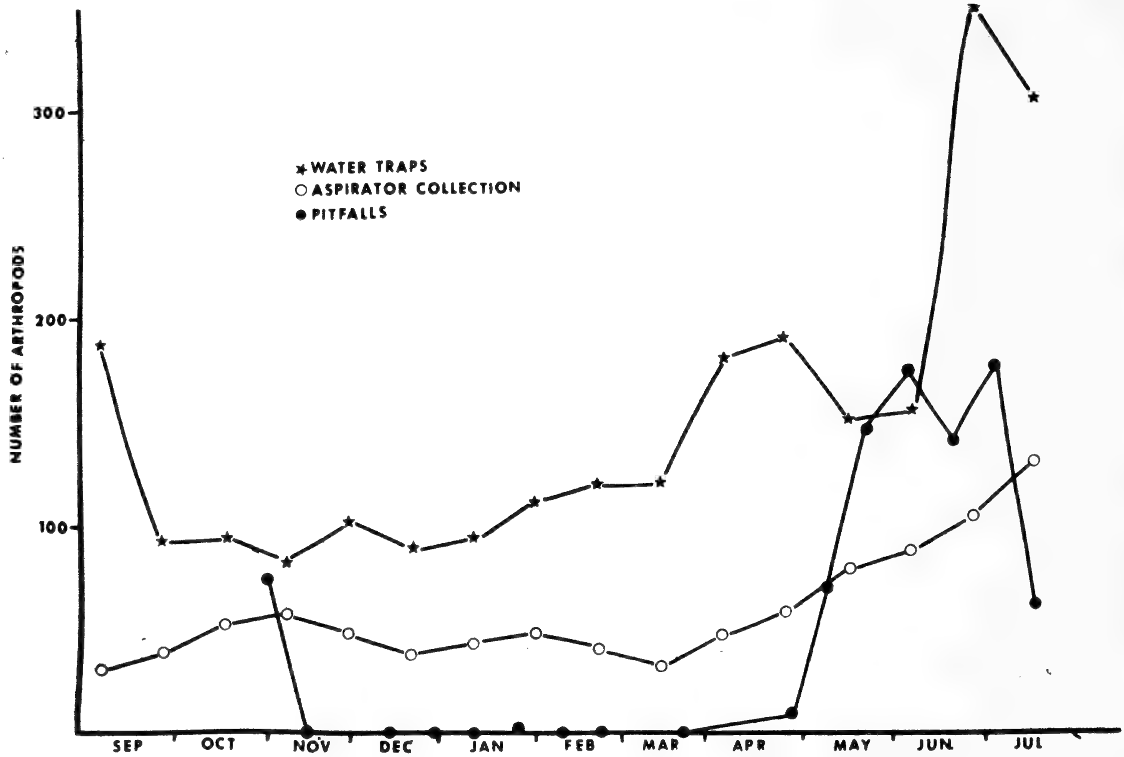


Fig. 7. Results of three Arthropod sampling methods. The pitfall traps were emptied every two weeks; the plotted point refers to the date of emtying. Because of decomposition problems only *Coleoptera* are included. Both the vegetation search with an aspirator and the placing of water traps were conducted weekly. For the purposes of the figure these were lumped into three week periods, with the plotted point at the central week. On four occasions through the year no data is available for one or other method. The collections for the three weekly period were then sealed up from the other two weeks.

45 'standard weeks' (for the commoner passerines, n=65 r=0.638, $p << 0.05$). The correlation is expected to be approximate because observation is biased towards larger, arboreal, species while mist nets catch the smaller, undergrowth dwelling, species. Nevertheless using the two methods in conjunction with each other can give reliable within species seasonal comparisons (see below).

sidered to be resident (see table 1) are plotted separately (Figure 9b).

General description of the annual cycle

Figure 10 gives, for selected species, the percentage of days observation in a month on which at least one individual of a given species was noted, and shows the seasonality in occurrence and/or observability of these species. The seasonality of species is shown also

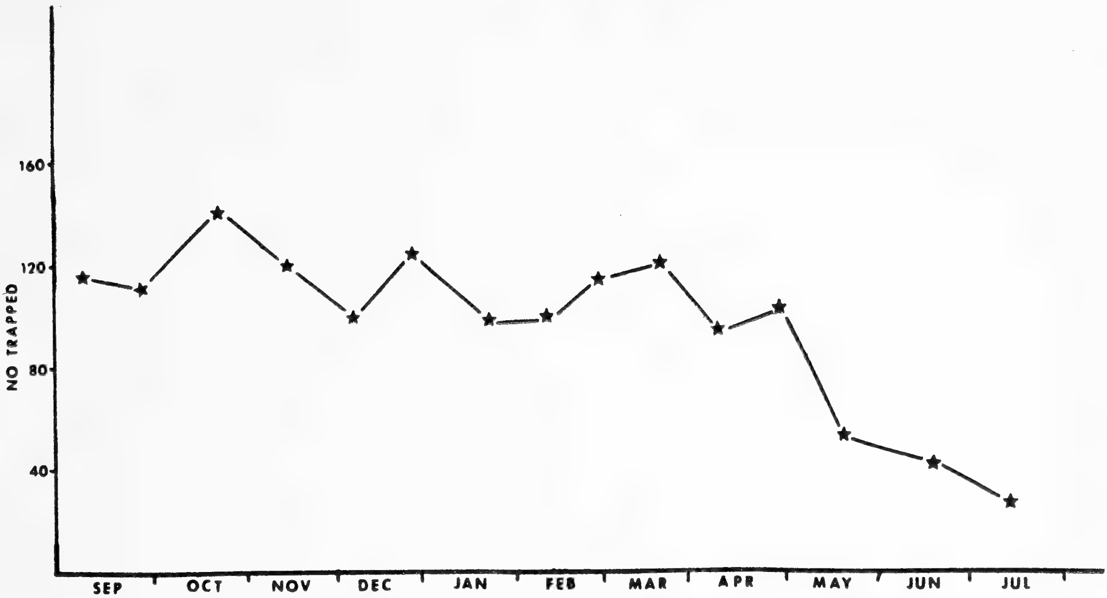


Fig. 8. Total catch in standard nets, grouped by three week periods, with the central week as the plotted point. The last point refers to two week's catch scaled up $1\frac{1}{2}$ times. Note that the trapping effort was reduced slightly in mid March, due to habitat clearance.

Between species comparisons are more difficult to make. Considering the area and height sampled by the standard nets as a habitat in itself, still leaves biases due to differing trapability and mobility between species. The total number of individuals captured in standard nets is shown in Figure 9a and corresponds roughly with the classic species abundance log normal curve (Preston 1962). A better approximation is obtained if the 70 species con-

in capture rates through the year (table 2) and is described verbally in the systematic list. Song periods for 17 species are given in Table 3. It should be emphasized that the information is derived from the 1976-1977 study period only. During wetter years (e.g. in 1977-1978) or in wetter areas (e.g. at Gudem) song begins earlier in the season.

The breeding season can be defined using moult periods, (Snow 1976, see below),

through direct observation of birds' behaviour, the discovery of nests (both summarized in the systematic list) and the appearance of juveniles. For all but a few species (notably the wren-warblers) September, that is, the time of commencement of the study is post breeding and birds are moulting (Table 4). Some juveniles are independent (notably the White-eye), many remain associated with adults; parental care was observed in the Small Minivet and Blackspotted Yellow Tit. Bulbuls are feeding mainly on fruiting bushes in the secondary growth area. Many of the more solitary species are inconspicuous. In the mature forest large mixed feeding flocks are seen containing up to 50 White-eyes and often the Small and Scarlet Minivets, Common Wood Shrike, Fulvousbreasted Woodpecker, Pied Flycatcher Shrike, Blacknaped Blue and Greyheaded Flycatchers and the two nuthatch species.

By mid October moult is being completed. Several species come into Autumn song and evict juveniles from territories, notably the Shama and Brook's Flycatcher (see Figure 11). Mixed feeding flocks break up and are not commonly seen through the Winter. Many small (10-15 birds) flocks of White-eyes move into the secondary growth area, and individuals from them may settle into restricted areas for

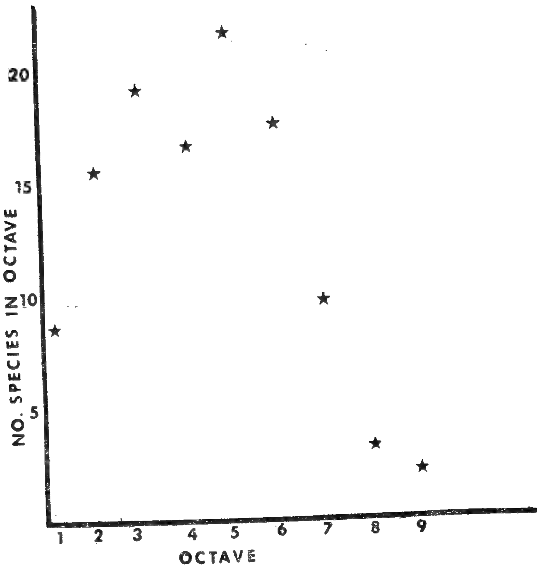


Fig. 9A

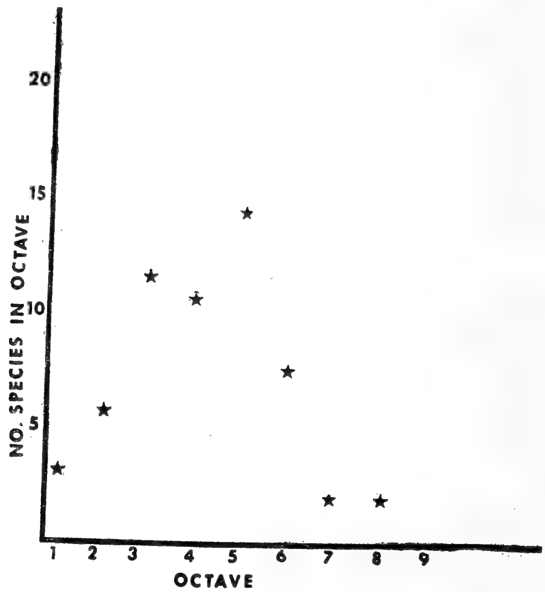


Fig. 9B

Fig. 9. Species-abundance curves. Octaves 1-9 refer to the number of captured individuals in standard nets of any one species, on a logarithmic (base 2) scale, (see Preston, 1962). Octave 1 contains 0-1 individuals, octave 2, 1-2 individuals, octave 3, 2-4 individuals, up to octave 9 (256-512 individuals). The number of species falling in the designated octave class is plotted as ordinate. Fig. 9A: For all species. Fig. 9B: For the 70 resident species only.

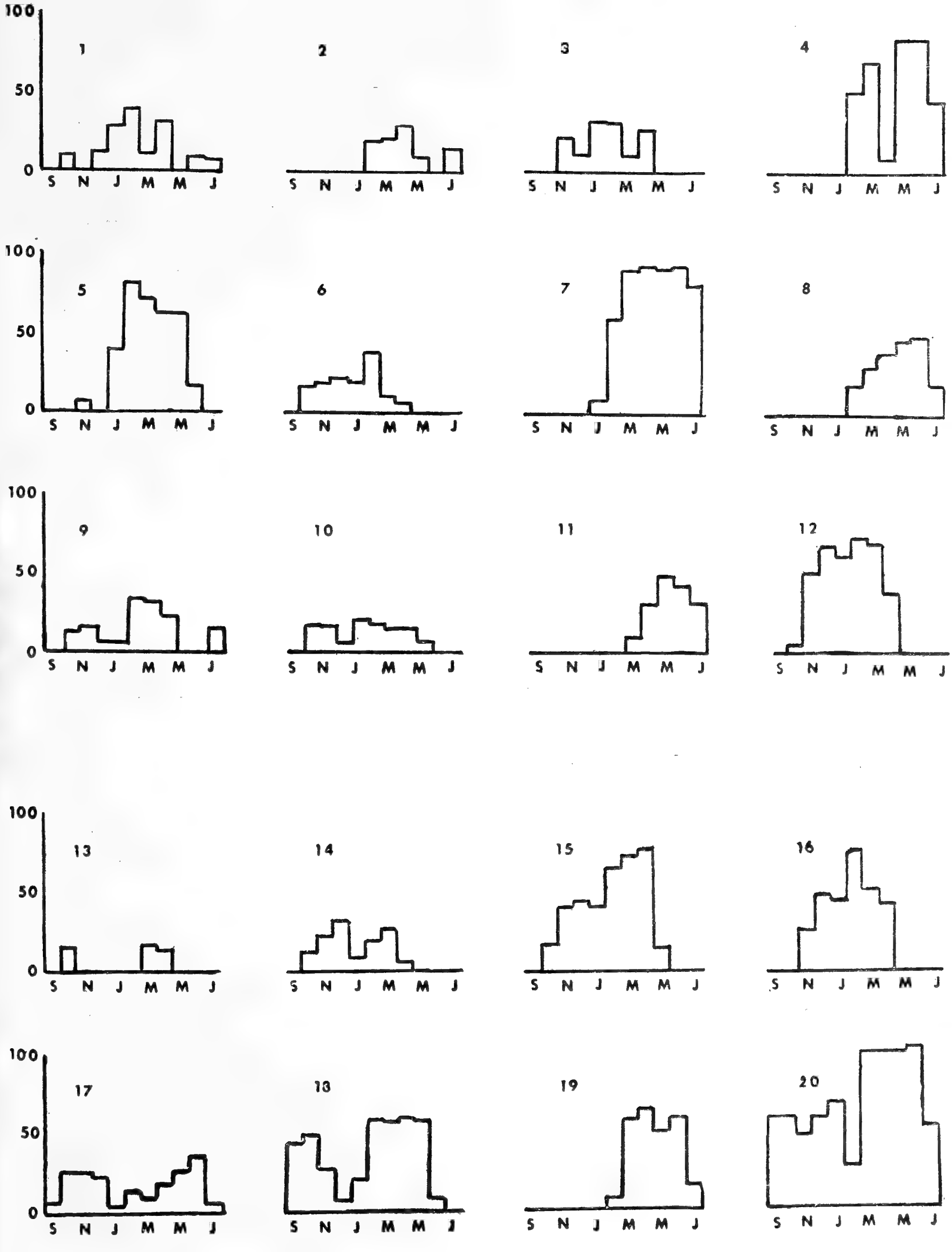


Fig. 10. The number of days in each month (from September 1976 to July 1977 inclusive) on which at least one individual of the given species was observed (except in the long-tailed nightjar which refers to number of times heard), expressed as a percentage of the total number of days observation in the month.

Number of days observation in each month are: September-14, October-26, December-19, January-25, February-16, March-20, April-26, May-23, June-12, July-16.

The species are: 1) Baybanded Cuckoo 2) Plaintive Cuckoo 3) Brown Shrike 4) Greyheaded myna 5) Hoopoe 6) Wryneck 7) Jungle Myna 8) Brahminy Myna 9) Blackheaded Cuckoo Shrike 10) Blue Chat 11) Rosy Minivet 12) Hodgson's Tree Pipit 13) Bluethroated Flycatcher 14) Rubythroat 15) Blyth's Reed Warbler 16) Common Rosefinch 17) Blacknaped Blue Flycatcher 18) Longtailed Nightjar 19) Green Pigeon 20) Magpie Robin.

the Winter. Passage migrants and Winter visitors arrive in numbers through October.

During the Winter months birds are inconspicuous and generally quite except around nectar and fruit sources. Over-wintering behaviour is detailed fully in the discussion. The first substantial rain fell on February 20th after which some breeding activity was seen. The silk cotton tree (*Bombax ceiba*) flowers from early February to mid March and attracts more than 30 species (Ali 1932), including large numbers of two Summer visitors, the Jungle and Greyheaded Mynas. Sunbirds are in breeding plumage by February-March. Most species, however, are going through a prenuptial moult (see below) and coming into song. April is the period of maximum song, the dawn chorus is particularly loud, with the Quaker Babbler and bulbuls conspicuous. Passage migrants are present in early April, and most Winter residents depart towards the end of the month. Song dies out through May and June. Many birds still sing, but each individual does so for shorter periods. Maximal breeding is between mid April and mid June. By July most of the breeding is over, adults become inconspicuous and go into the postnuptial moult.

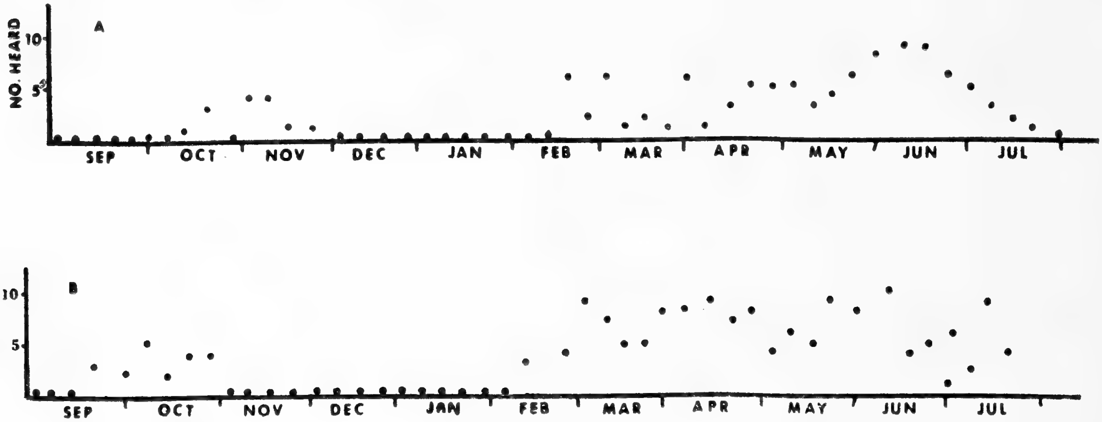


Fig. 11. The number of birds heard singing on the weekly five kilometre post-dawn walk. Fig. 11A—Shama. Fig. 11B—Brooks's Flycatcher.

Moult and weight data

Because of the scarcity of weight data for Indian birds, a summary of weights is given in table 1. No attempt has been made to analyse the data for seasonal weight changes. A few individuals were noted which increased weight abruptly during the breeding season; these were probably females carrying eggs as Fogden (1972) concluded, from a study in Sarawak and are excluded from the weight summary (table 1).

All species, as far as is known go through a complete post nuptial moult. Table 4 lists the proportion of individuals in moult for selected periods. In some cases it was known that non moulting individuals had yet to start their moult. In many species there is a complete post juvenile moult, although this could definitely be shown only for the Redwhiskered and Redvented Bulbuls and the Redfronted Babbler at Lammasinghi. Figure 13 plots right wing primary moult score against data for

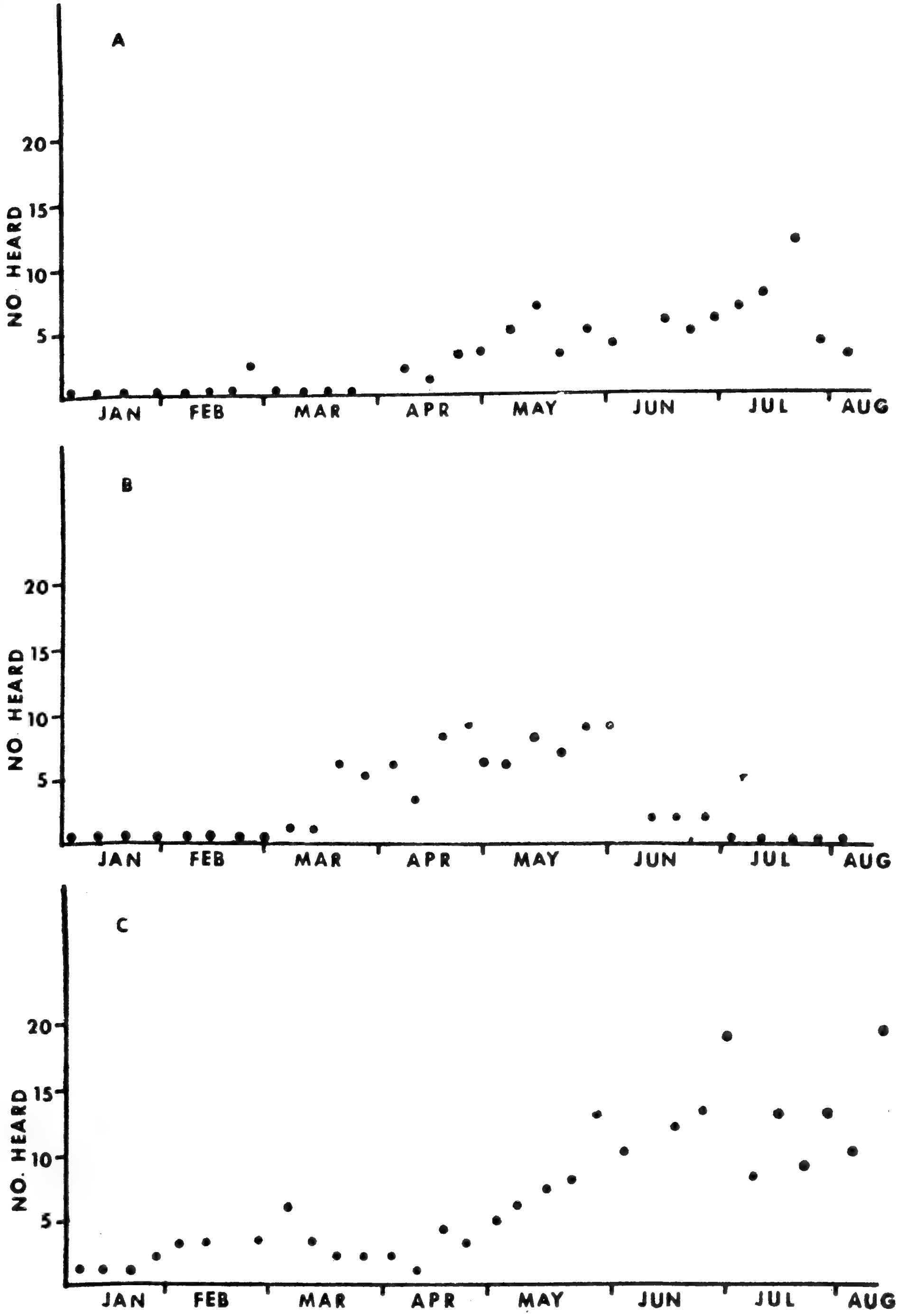


Fig. 12. The number of birds heard singing on the weekly five kilometre post dawn walk. Fig. 12A—Yellow Breasted Babbler (the "chwonk...chwonk" call (Ali and Ripley, 1971)). Fig. 12B—Magpie Robin. Fig. 12C—Common Iora.

TABLE 1

TRAPPING DATA

Species	Status	Total trapped	% Days observed	Habitat preference	Mean	s.e.	Weights Max.	Min.
Crested Goshawk	R	1	—	—	—	—	—	—
Painted Bush Quail	R	10	—	S	56	14.1	76	38.5
Button Quail	R	8	—	S	53	9.6	70	44
Common Bustard Quail	R	3	—	S	48(2)	—	53	43
Orangebreasted Green Pigeon	S	2	22	B	175	—	194	155
Rufous Turtle Dove	W	1	2	S	207	—	—	—
Spotted Dove	R	15	99	B	106	9.8	119	96
Emerald Dove	R	13	25	F	121	11.1	158	143
Blossomheaded Parakeet	R	3	37	S	62(2)	—	65	59
Indian Lorikeet	R	1	40	B	27.4	—	—	—
Small Cuckoo	P	2	1	S	47.5	—	48	47
Baybanded Cuckoo	R	4	13	B	35.4	1.6	37.7	33.1
Plaintive Cuckoo	S	7	8	B	31.9	2.2	35.3	29.2
Koel	–	1	0	S	180	—	—	—
Large Greenbilled Malkoha	–	1	0	—	139	—	—	—
Scops Owl	–	1	—	—	70	—	—	—
Collared Scops Owl	R	2	—	—	145	—	146	143
Indian Jungle Nightjar	–	1	—	—	—	—	—	—
Longtailed Nightjar	R	2	0	S	94	—	118	70
Palm Swift	R	4	62	—	9.2	0.8	10.0	8.3
Malabar Trogon	R	3	2	F	68	4.6	73	62
Chestnutheaded Bee-eater	W	1	6	S	26.5	—	—	—
Bluebearded Bee-eater	R	4	11	B	92	4.8	97	85
Hoopoe	S	10	32	B	54(9)	7.0	62	40
Large Green Barbet	R	23	45	B	102	7.6	115	90
Coppersmith	R	11	32	B	34.5	2.4	38.3	31.6
Wryneck	W	5	12	S	33.8	2.3	37.3	30.9
Speckled Piculet	R	23	20	B	11.8	0.7	13.2	10.5
Small Yellownaped Woodpecker	R	3	10	F	67	—	75	60
Fulvousbreasted Pied Woodpecker	R	4	14	B	40.6	1.8	42.8	38.2
Pigmy Woodpecker	R	3	10	B	15.8	1.1	17.0	14.3
Indian Pitta	P	2	1	B	55	—	55.5	55
Striated Swallow	R	9	35	S	17.3	1.1	18.5	15.5
Rufousbacked Shrike	R	14	46	S	37(13)	2.8	42.5	30
Brown Shrike	P,W	16	20	S	29.7	2.1	32.8	24.6

TABLE 1 (cont.)

Species	Status	Total trapped	% Days observed	Habitat preference	Mean	s.e.	Weights Max.	Min.
Grey Drongo	R	5	53	F	43	2.4	46	39
Bronzed Drongo	–	2	4	—	23.1	—	23.8	22.4
Greyheaded Myna	S	29	36	S	38.5	1.9	41.8	35.6
Brahminy Myna	S	2	18	S	49	—	52	47
Jungle Myna	S	1	4	S	81	—	—	—
Himalayan Tree Pie	R	1	34	S	94	6.6	102	84
Pied Flycatcher Shrike	R	22	43	B	9.0	0.5	9.8	8.2
Large Wood Shrike	R	10	21	F	36.3	2.2	40	33
Common Wood Shrike	R	6	10	B	21.2	1.4	23.3	19.3
Smaller Grey Cuckoo Shrike	W	3	4	S	36.7	2.0	38.0	34.4
Blackheaded Cuckoo Shrike	R	11	12	S	29.6	2.3	32.5	26.0
Scarlet Minivet	R	6	48	B	27.7	2.5	31.5	23.4
Rosy Minivet	S	1	15	F	19.8	—	—	—
Small Minivet	R	1	38	F	9.3	—	—	—
Common Iora	R	40	60	B	14.4(38)	1.1	16.7	12.2
Goldfronted Chloropsis	R	2	18	B	34.2	—	34.8	33.7
Blackheaded Yellow Bulbul	R	9	18	F	28.0	3.3	32.1	20.2
Redwhiskered Bulbul	R	211	100	B	28.1(200)	2.4	35.3	19.6
Redvented Bulbul	R	147	100	B	32.9(135)	2.9	40.2	23.6
Whitebrowed Bulbul	R	9	5	S	33.9	3.7	37.2	31.3
Spotted Babbler	R	37	35	B	26.9(36)	1.9	30.7	22.6
Slatyheaded Scimitar Babbler	R	8	7	F	43.3(7)	1.8	44.7	41.2
Redfronted Babbler	R	24	17	B	9.2	0.2	10.4	8.2
Rufousbellied Babbler	R	40	39	S	13.0(38)	1.1	15.4	11.2
Yellowbreasted Babbler	R	28	20	F	11.6(26)	0.9	13.7	10.7
Yelloweyed Babbler	R	28	24	S	19.3(26)	1.5	21.8	15.7
Jungle Babbler	R	1	5	S	66	—	—	—
Quaker Babbler	R	57	34	B	20.7(54)	1.2	23.3	18.2
Brown Flycatcher	–	2	3	W	11.8	—	11.8	11.7
Rufoustailed Flycatcher	P	1	0	—	13.1	—	—	—
Redbreasted Flycatcher	W,P	13	25	S	10.6	1.2	13.3	8.3
Whitebrowed Blue Flycatcher	W	4	9	F	7.8	0.4	8.5	7.3
Brooks's Flycatcher	R	34	34	F	15.7	1.0	16.4	14.0
Bluethroated Flycatcher	P	10	5	S	14.6	2.0	19.0	12.4
Verditer Flycatcher	W	4	11	F	17.5	0.2	17.7	17.3
Greyheaded Flycatcher	R	8	16	F	7.2	0.6	8.2	6.3
Whitebrowed Fantail Flycatcher	R	1	3	F	11.2	—	—	—

TABLE 1 (contd.)

Species	Status	Total trapped	% Days observed	Habitat preference	Mean	s.e.	Weights Max.	Min.
Whitethroated Fantail Flycatcher	R	4	7	S	10.4	—	11.4	9.8
Blacknaped Blue Flycatcher	R	20	18	F	10.7	0.9	12.6	9.2
Ashy-grey Wren Warbler	R	12	13	S	6.9	1.0	8.5	5.7
Ashy Wren Warbler	R	25	27	S	7.7(23)	0.6	9.0	6.0
Jungle Wren Warbler	R	8	22	S	15.7	1.3	18.0	13.3
Tailor Bird	R	104	96	B	8.3(101)	0.7	9.8	6.9
Grasshopper Warbler	W	2	0	S	10.7	—	11.3	10.0
Thickbilled Warbler	W	4	2	S	24.7	1.5	27.0	23.4
Blyth's Reed Warbler	W	56	35	S	10.7	0.9	13.2	9.2
Tickell's Leaf Warbler	–	2	0	—	5.5	—	5.6	5.3
Yellowbrowed Leaf Warbler	W	7	7	F	5.3	0.3	5.7	4.7
Largebilled Leaf Warbler	P	10	5	F	10.4	1.3	12.2	7.7
Greenish Warbler	P,W	98	86	B	6.9(91)	0.7	8.6	5.6
Largecrowned Leaf Warbler	W	2	3	F	8.4	—	8.7	8.1
Yelloweyed Flycatcher Warbler	W	1	0	—	6.6	—	—	—
Rubythroat	W	14	11	S	20.6	1.4	22.9	18.6
Bluethroat	W	1	0	S	16.3	—	—	—
Blue Chat	P,W	24	11	B	17.1	2.0	20.4	13.0
Magpie Robin	R	27	68	B,S	33.6	2.6	37.8	29.8
Shama	R	46	50	F	28.9(43)	2.9	33.7	20.5
Pied Bush Chat	R	11	78	S	15.4(10)	1.2	17.2	13.9
Blueheaded Rock Thrush	P,W	6	5	F	34.4	2.2	38.4	31.6
Pied Ground Thrush	P	0	5	F	62	—	64	60
Orangeheaded Ground Thrush	P	5	3	F	53.5	—	62	48
Whitethroated Ground Thrush	R	32	30	B	54.5	3.0	60	50
White's Mountain Thrush	–	2	1	F	109	—	109	108
Tickell's Thrush	W	2	2	—	57.5	—	58	57
Blackbird	R	17	17	F	80(15)	4.6	80.5	65
Blackspotted Yellow Tit	R	56	81	B	16.9	1.2	19.7	14.6
Chestnutbellied Nuthatch	R	10	44	B	16.1	0.7	16.8	14.9
Velvetfronted Nuthatch	R	15	31	F	12.5	0.7	13.7	11.8
Hodgson's Tree Pipit	W	18	36	S	21.4	1.4	23.8	19.4
Forest Wagtail	P	3	5	F	17.4	1.2	19.0	16.2
Grey Wagtail	P,W	11	57	—	15.4	1.1	18.2	14.2
Thickbilled Flowerpecker	R	5	11	F	8.2	0.2	8.5	7.8
Tickell's Flowerpecker	R	42	41	B	6.0(40)	0.5	6.8	5.2

2

TABLE 1 (contd.)

Purplerumped Sunbird	R	18	55	B	7.1	0.5	8.3	6.5
Purple Sunbird	R	24		B	7.3(23)	0.7	8.6	5.5
Little Spiderhunter	R	1	0	—	11.6	—	—	—
White-eye	R	213	96	B	8.5	0.7	10.2	6.5
Baya	–	9	6	S	24.5	1.2	26.0	23.3
Whitebacked Munia	R	40	22	S	11.8	0.9	14.7	10.0
Jerdon's Munia	R	39	28	S	14.6	1.0	16.6	12.3
Spotted Munia	R	6	11	S	13.6	0.9	15.5	11.5
Common Rosefinch	W	62	27	S	21.7(59)	1.7	18.5	25.0

Following is an explanation of column headings. *Status.* R—resident, S—Summer visitor, W—Winter visitor, P—passage migrant. *Total trapped.* Total numbers of individuals trapped in all nets in 1976-1977 and 1978. Four species trapped were not trapped in "standard" nets (see text)—the Indian Jungle Nightjar, the Scops Owl, the Palm Swift and Tickell's Leaf Warbler. % *Days observed*: There were 221 days total observation; this column records the number of days (as a percentage) that at least one individual of the given species was seen. *Habitat preference*: the habitat in which the species is most commonly found. F—mature forest, S—secondary growth. B—both habitats. *Weights.* Mean (with sample size in brackets if different from the total trapped), standard error, and range are given.

TABLE 2

SEASONALITY IN CAPTURE AND RECAPTURE RATES FOR ALL SPECIES IN WHICH MORE THAN TEN INDIVIDUALS WERE TRAPPED. FOR EACH SPECIES THE TOP LINE GIVES THE NUMBER OF INDIVIDUALS CAPTURED IN A GIVEN PERIOD WHICH HAD NOT BEEN PREVIOUSLY CAPTURED, AND THE BOTTOM LINE THE NUMBER OF INDIVIDUALS WHICH ARE RECAPTURES FROM A PREVIOUS PERIOD. EACH INDIVIDUAL IS COUNTED ONCE PER PERIOD. AN INDEX OF "SEDENTARINESS" (SEE TEXT, % RECAPTURES, COLUMN 1) IS OBTAINED BY SUMMING THE BOTTOM LINE OVER THE 1976-1977 PERIODS AND TAKING THIS AS A PERCENTAGE OF THE SUM OF THE BOTTOM AND TOP LINES OVER THE 1976-1977 PERIODS.

Species	% Rec.	29 Aug.- 2 Oct.	3 Oct- 6 Nov.	7 Nov- 11 Dec.	12 Dec- 15 Jan.	16 Jan- 19 Feb.	20 Feb.- 26 Mar.	27 Mar.- 30 Apr.	1 May- 4 Jun.	12 Jun.- 16 Jul.	3 Jan.'78. 7 Feb '78
		4	0	0	3	1	2	0	1	0	2
Spotted Dove	0	0	0	0	0	0	0	0	0	0	0
		0	0	1	0	2	1	0	3	0	3
Hoopoe	0	0	0	0	0	0	0	0	0	0	0
		7	3	1	0	0	1	8	3	0	0
Large Green Barbet	21	0	0	0	0	1	1	1	3	0	0
		0	0	0	0	0	1	5	1	4	0
Coppersmith	0	0	0	0	0	0	0	0	0	0	0
		3	3	3	1	0	0	5	4	1	0
Speckled Piculet	35	0	0	1	3	1	3	1	2	0	0
		4	0	1	0	1	1	0	0	3	2
Rufousbacked Shrike	20	0	0	0	1	1	0	1	0	0	0

TABLE 2 (Contd.)

Species	% Rec.	29 Aug- 2 Oct.	3 Oct- 6 Nov.	7 Nov- 11 Dec.	12 Dec- 15 Jan.	16 Jan- 19 Feb.	20 Feb- 26 Mar.	27 Mar- 30 Apr.	1 May- 4 Jun.	12 Jun- 16 Jul.	3 Jan '78- 7 Feb '78
Brown Shrike	6	2	6	1	0	0	0	1	0	0	5
		0	1	0	0	0	0	0	0	0	0
Greyheaded Myna	0	0	0	0	0	0	1	9	8	1	0
		0	0	0	0	0	0	0	0	0	0
Pied Flycatcher Shrike	26	1	3	1	2	0	0	2	3	0	2
		0	0	0	0	1	2	0	0	0	2
Large Wood Shrike	9	1	0	0	1	5	3	0	0	0	0
		0	0	0	0	0	1	0	0	0	0
Common Iora	44	12	1	4	1	1	2	6	1	0	2
		0	2	2	5	3	3	4	3	2	0
Redwhiskered Bulbul	14	57	19	17	2	2	13	27	22	17	8
		0	3	2	3	1	4	6	8	2	1
Redvented Bulbul	28	23	21	19	4	7	13	8	10	7	9
		0	6	2	4	4	3	7	14	3	5
Spotted Babbler	43	12	8	0	2	6	0	1	1	4	0
		0	3	5	2	5	1	3	4	1	1
Redfronted Babbler	60	4	6	3	3	1	0	0	0	0	4
		0	2	2	3	4	7	4	1	2	6
Rufousbellied Babbler	59	13	4	3	2	0	2	0	4	0	3
		0	7	3	10	3	5	8	1	1	6
Yellowbreasted Babbler	30	3	4	1	4	10	3	0	1	0	2
		0	1	1	3	4	4	2	1	0	2
Yelloweyed Babbler	34	4	3	1	0	0	2	2	4	0	7
		0	1	1	2	1	2	1	1	0	3
Quaker Babbler	37	17	1	5	12	4	0	3	1	3	6
		0	0	1	7	9	2	3	2	3	4
Redbreasted Flycatcher	0	0	3	0	1	0	1	7	0	0	0
		0	0	0	0	0	0	0	0	0	0
Brooks's Flycatcher	42	11	15	1	1	3	2	1	0	1	3
		0	0	6	5	2	4	1	3	1	1
Blacknaped Blue Flycatcher	9	3	3	4	2	1	3	1	1	1	1
		0	0	0	1	0	1	0	0	0	0
Ashy Wren Warbler	43	7	2	2	0	1	5	1	2	0	1
		0	2	0	3	2	1	4	3	0	1
Tailor Bird	44	31	8	6	3	4	9	3	2	4	11
		0	11	4	13	6	9	11	4	4	2
Blyth's Reed Warbler	45	0	4	8	2	1	10	12	1	0	6
		0	0	2	2	4	4	6	1	0	1

TABLE 2 (Contd.)

Species	% Rec.	29 Aug- 2 Oct.	3 Oct- 6 Nov.	7 Nov- 11 Dec.	12 Dec- 15 Jan.	16 Jan- 19 Feb.	20 Feb- 26 Mar.	27 Mar- 30 Apr.	1 May- 4 Jun.	12 Jun- 16 Jul.	3 Jan '78- 7 Feb '78
Largebilled Leaf Warbler	0	1	6	0	0	0	0	3	0	0	0
		0	0	0	0	0	0	0	0	0	0
Greenish Warbler	40	15	28	7	8	5	16	9	2	0	1
		0	3	17	15	10	10	5	0	0	4
Rubythroat	46	0	5	3	1	1	1	0	0	0	2
		0	0	3	2	1	3	1	0	0	1
Blue Chat	8	1	9	4	1	1	2	3	3	0	0
		0	0	0	0	1	0	1	0	0	0
Magpie Robin	27	3	4	0	1	0	4	7	4	3	1
		0	1	1	3	1	0	0	1	1	2
Shama	18	6	10	0	3	2	3	2	4	8	3
		0	0	2	0	2	1	0	2	0	2
Whitethroated Ground Thrush	28	0	7	5	3	2	1	5	3	3	0
		0	0	0	0	3	2	2	2	1	1
Blackbird	11	0	8	1	2	2	0	0	0	0	3
		0	0	1	1	0	0	0	0	0	0
Blackspotted Yellow Tit	48	12	1	7	0	5	3	2	5	3	7
		0	4	4	5	7	5	6	2	5	4
Chestnutbellied Nuthatch	33	1	1	1	1	2	2	2	0	0	0
		0	0	0	0	1	1	1	2	1	0
Velvetfronted Nuthatch	25	2	2	0	1	6	0	3	0	0	1
		0	0	1	2	0	0	2	0	0	0
Hodgson's Tree Pipit	10	0	1	6	6	2	1	0	0	0	2
		0	0	0	1	0	0	0	0	0	0
Tickell's Flowerpecker	15	2	1	2	4	4	5	13	3	3	3
		0	0	1	1	1	2	1	0	0	0
Purplerumped Sunbird	14	0	0	4	1	3	8	1	0	1	1
		0	0	0	1	2	0	0	0	0	0
Purple Sunbird	21	1	3	3	1	2	1	3	2	2	1
		0	0	0	0	2	1	0	1	0	1
White-eye	38	27	23	44	5	29	24	16	13	7	1
		0	6	12	15	26	16	16	13	8	5
Whitebacked Munia	0	1	1	9	9	3	9	1	6	3	0
		0	0	0	0	0	0	0	0	0	0
Jerdon's Munia	0	2	0	8	16	0	2	2	0	2	0
		0	0	0	0	0	0	0	0	0	0
Spotted Munia	0	13	8	6	7	4	0	0	1	4	0
		0	0	0	0	0	0	0	0	0	0
Common Rosefinch	2	0	0	8	8	8	12	12	0	0	7
		0	0	0	0	1	0	0	0	0	0

selected species. Moult score is taken in the standard way [0 for an old feather, 1 for a feather in pin, 5 for a new feather and intermediate values for intermediate lengths, see Newton (1966)], giving a maximum of 50 points (or 45 in White-eyes and Munias) for a new wing. Relatively early moult in sunbirds and barbets (data not presented) and late moult in Wren-Warblers is in accordance with relative shifts in the timing of breeding.

In Spring many species undergo a partial moult of body and tail feathers. The Quaker Babbler and Wren-Warblers undergo a second complete moult, and the Greenish Warbler and Brown Shrike a complete premigratory moult.

Sedentariness and Distribution Between Habitats

The proportion of birds carrying rings in any one day's trapping summed over three week periods is plotted in Figure 14 (sample sizes are given in Figure 9). The recapture rate rises steadily until the end of January, except during October, when there is increased dispersal and an influx of migrants. It then drops until mid April, associated with prebreeding dispersal (although some movements will be due to the felling operations conducted at this time). During the breeding season birds are again sedentary. After June, juveniles in the catch decrease the recapture rate.

Some species move locally more than others. Captures in late Winter of some species may be entirely of retraps (table 2). Summing the total number of recaptures over the ten five-week "standard periods" (table 2) and taking this as a percentage of total new captures plus recaptures gives an impression of long term sedentariness in the study area. The majority of individuals were recaptured at the same net site as previously captured, or one close by. High sedentariness thus implies a territory or home range. Small babblers had the highest recapture rate, flocks being repeatedly retrapped. Bulbuls had low recapture rates; it should be noted that this demonstrates movement in the vertical as well as horizontal dimension.

Some species are confined to mature woodland, some to secondary growth, and others to both (table 1). The large number of species in the last category to some extent reflects the close proximity of the two habitats. Elsewhere in the Ghats, in wider expanses of uniform habitat species diversity is reduced in any given habitat. Although more species of Palaearctic migrants are found in the secondary growth they are also found in numbers in mature forest [c/f observations in Africa, notably in evergreen forest (Moreau 1972, Karr 1976b)]. There are seasonal changes in use of the two habitats. Wren-Warblers and Whitebrowed Bulbuls, for instance, are occasionally found in forest clearings when it is most desiccated, during pre-breeding dispersal. Redwhiskered and Redvented Bulbuls and White-eyes are commonest in the forest during and immediately after the breeding season. Magpie Robins only occur in the forest to breed.

The Occurrence of Summer Visitors

Several species (notably the Hoopoe, Rosy Minivet, Orangebreasted Green Pigeon, Plaintive Cuckoo and the Jungle, Brahminy and Greyheaded Mynas—see table 1) are Summer visitors to the area. They all breed and it is clear (in the non-parasitic species at least) that they are arriving to exploit seasonally available food sources (mainly large insects, and fruit). This is particularly obvious in the case of the Orangebreasted Green Pigeon which feeds mainly on such trees as *Ficus tsiela* and *Bridelia tomentosa,* which fruit seasonally. The hypothesis presented is that

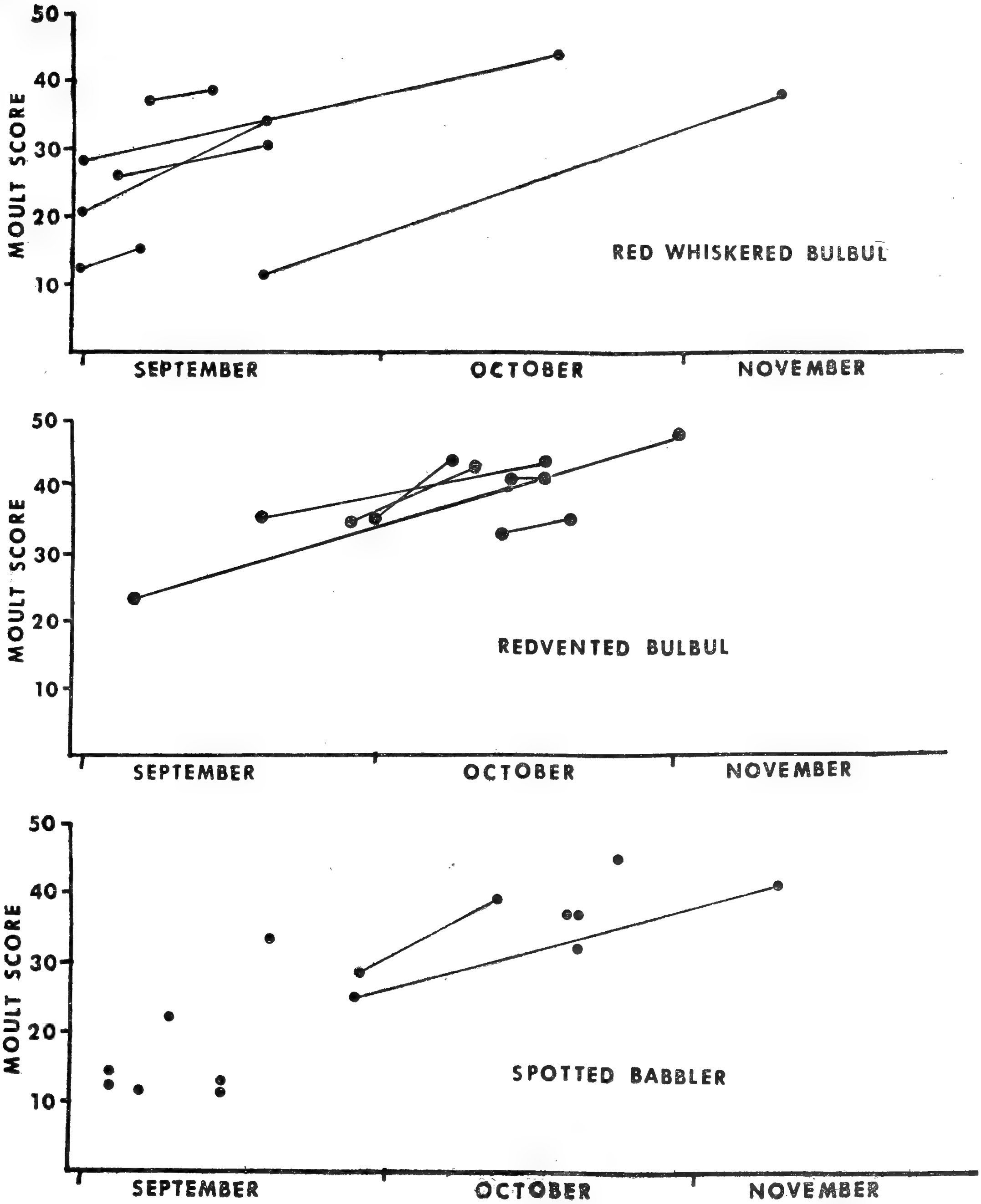

50
40
30
20
10
MOULT SCORE
RED WHISKERED BULBUL
SEPTEMBER
OCTOBER
NOVEMBER
50
40
30
20
10
MOULT SCORE
REDVENTED BULBUL
SEPTEMBER
OCTOBER
NOVEMBER
50
40
30
20
10
MOULT SCORE
SPOTTED BABBLER
SEPTEMBER
OCTOBER
NOVEMBER

Fig. 13.

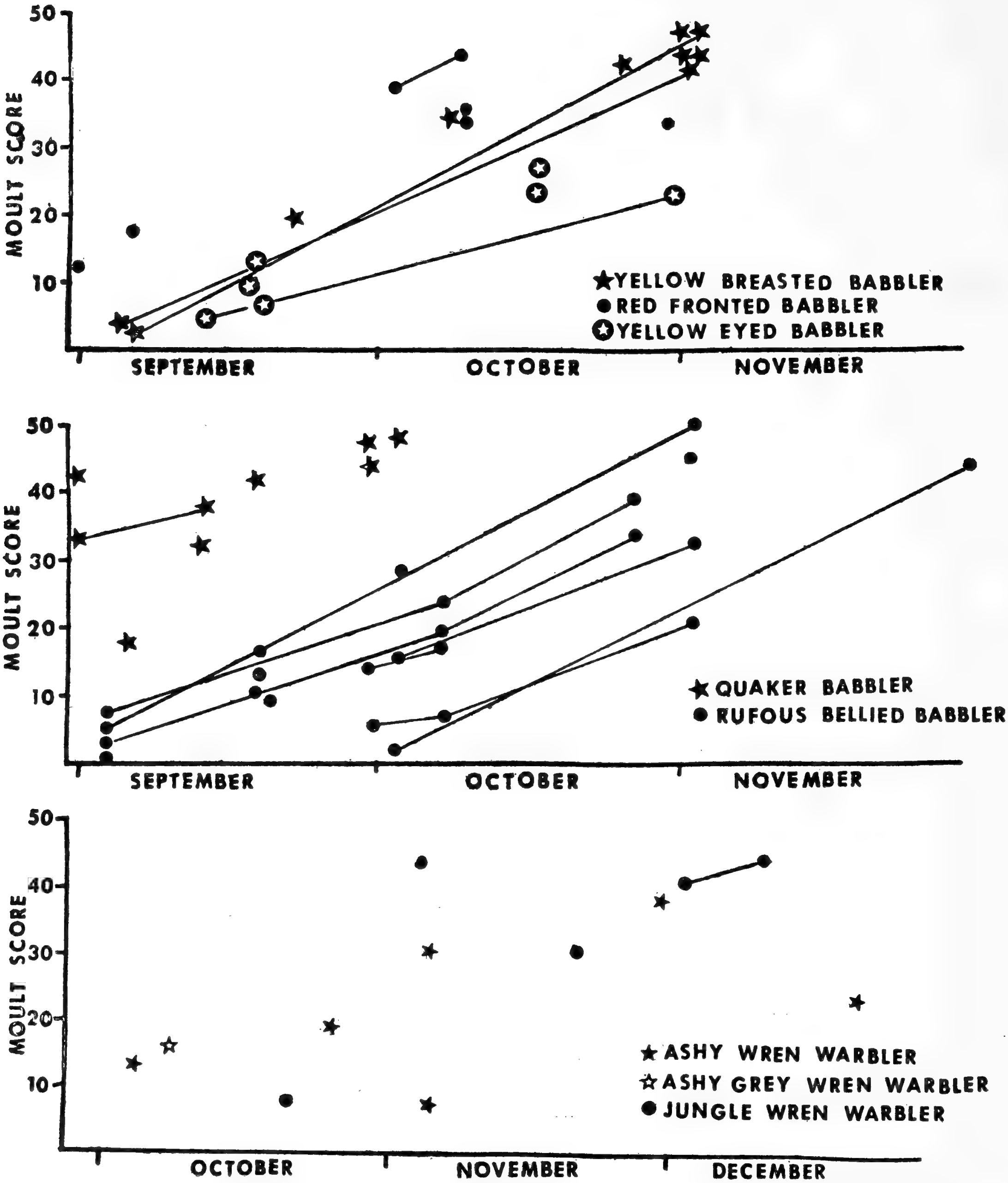

MOULT SCORE
50
40
30
20
10
SEPTEMBER
OCTOBER
NOVEMBER
YELLOW BREASTED BABBLER
RED FRONTED BABBLER
YELLOW EYED BABBLER
MOULT SCORE
50
40
30
20
10
SEPTEMBER
OCTOBER
NOVEMBER
QUAKER BABBLER
RUFOUS BELLIED BABBLER
MOULT SCORE
50
40
30
20
10
OCTOBER
NOVEMBER
DECEMBER
ASHY WREN WARBLER
ASHY GREY WREN WARBLER
JUNGLE WREN WARBLER

Fig. 13.

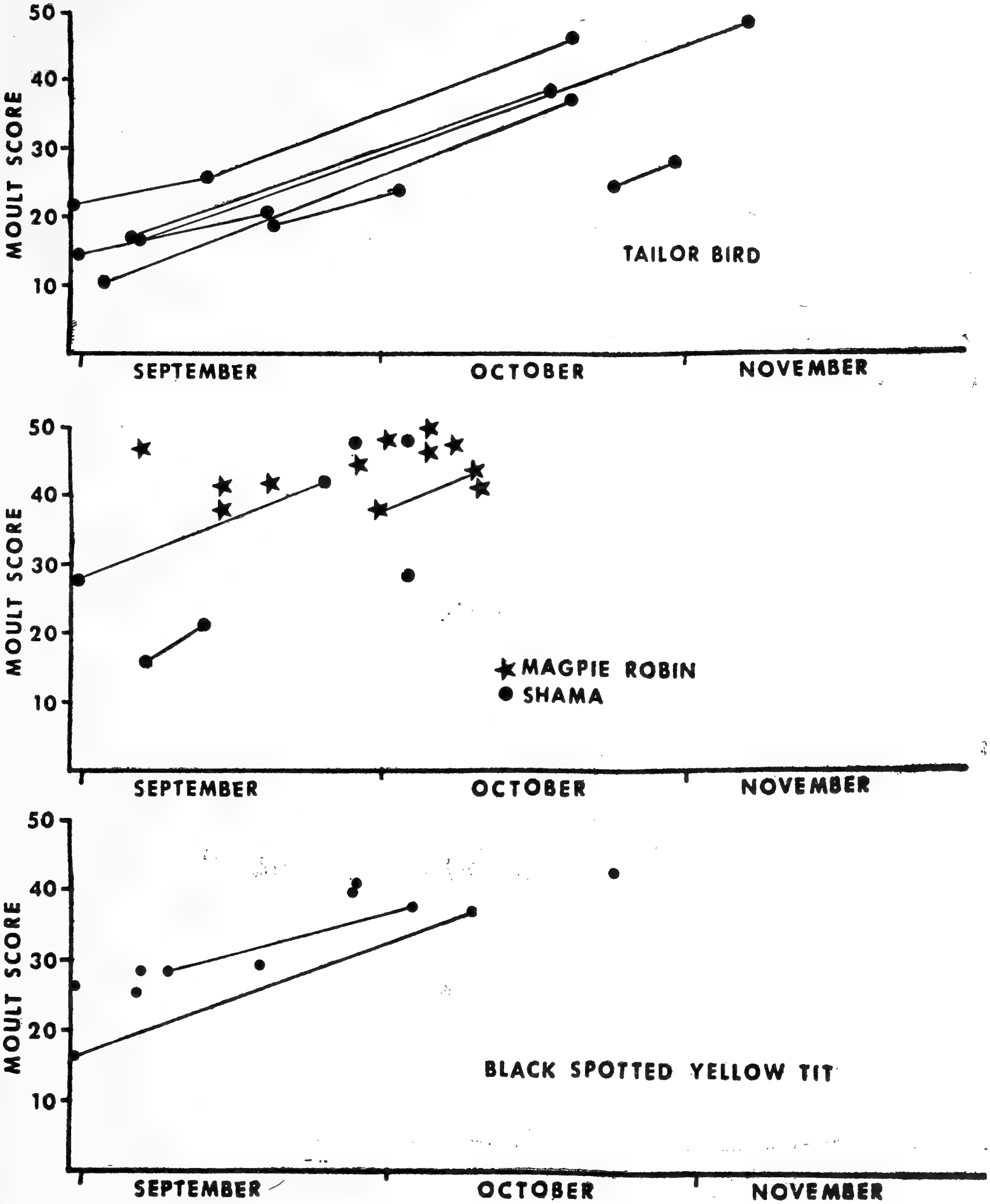

50
40
30
20
10
MOULT SCORE
TAILOR BIRD
SEPTEMBER
OCTOBER
NOVEMBER
50
40
30
20
10
MOULT SCORE
MAGPIE ROBIN
SHAMA
SEPTEMBER
OCTOBER
NOVEMBER
50
40
30
20
10
MOULT SCORE
BLACK SPOTTED YELLOW TIT
SEPTEMBER
OCTOBER
NOVEMBER

Fig. 13.

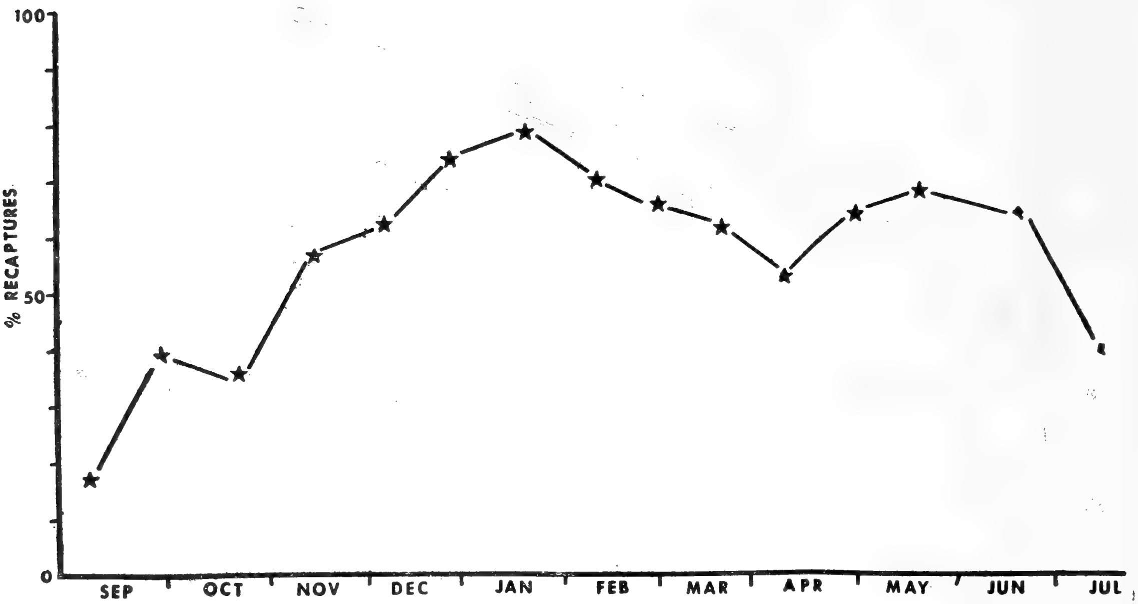


Fig. 13. Moult score in selected species. Lines join points for the same individual. All individuals trapped are shown except for the bulbuls when only recaptured individuals are shown.

it is excluded from the occasional fruiting tree in Winter by more aggressive species (i.e. the barbets), but is well adapted for migration (c/f the barbets which appear weak flyers).

The Occurrence of Palaearctic Migrants

In contrast to Summer visitors the appearance of Palaearctic migrants is largely governed by changing conditions in the north temperate regions (Karr 1976b), although departure in Spring may be delayed until food levels rise in the Winter quarters. Some species are encountered only as passage migrants, others winter in the area (table 1). The proportion of Palaearctic migrants in each five week period (as a percentage of the total excluding Summer Visitors) is given in table 5. Karr (1976b), based on very small sample sizes concluded that the proportion of Palaearctic migrants in a forest at Mahableshwar (and extrapolated to cover much of India) was 50-78%, as opposed to the 20% he found in more detailed studies in Africa and Panama. My fuller data shows his conclusion to be probably incorrect. Personal observations at Kerala and near Bombay suggest that a similar proportion of migrants occur at these localities to that at Lammasinghi, and 20% is a more accurate figure for the whole of India.

Longevity

It is now recognized that Passerines in the tropics have longer life expectancy at adulthood than those of temperate regions (Karr 1971, Fogden 1972, Lack 1966). While impossible to present quantitative data on this, mainly because of the wider area over which ringing teams in 1971 and 1972 worked and because birds move, it seems worthwhile to present data on all species recaptured from those camps, (table 6). The list is impressive particularly the reappearance of the Greenish

Warbler, a Palaearctic migrant and the Plaintive Cuckoo, a Summer visitor.

Discussion

Overwintering Strategies

Several lines of evidence point to the December-February period as a time of food shortage for many species. Firstly, the Arthropod collections, and qualitative observations on fruit abundance show that food levels are at their lowest during this period, as would be predicted from the climate. Fruit is seen rotting under *Ficus* trees in June, none was found under a fruiting *Ficus benghalensis* in January. Secondly, the birds themselves show no activity additional to maintenance requirements; that is, there is no moulting or breeding activity, and little song. Thirdly, there is an appreciable amount of fighting over fruit and nectar sources; this was particularly noted at a few Eucalyptus blossoms in January, intraspecifically among White-eyes and inter-specifically between the *Chloropsis* and other visiting species. It should be noted that day length is approximately one and a half hours shorter in mid Winter as compared with mid Summer, the nights are cold (Figrue 3), and there are very thick, condensing, early morning fogs.

Feeding habits change in the Winter. The change for many species may be summarised in saying that there is less arboreal foraging and more time spent close to ,or on the ground. I distinguish several overwintering strategies for species that are Winter residents (either permanent residents or Winter visitors).

(1) *Individual dispersal.* Individuals may vacate their breeding and/or Autumn location. The Ashy Wren-Warbler, for example, is found in forest clearings, and some species almost entirely vacate the area, presumably moving to lower elevations [e.g. the Blacknaped Blue Flycatcher (Figure 10) and Bluebearded Bee-eater]. In two species—the Magpie Robin and Pied Bush Chat, some individuals migrate while others remain on territory throughout the Winter.

(2) *Flocking on clumped food sources.* Fruit trees have assemblage of barbets and bulbuls. Nectar sources are visited mainly by White-eyes and Lorikeets. The occasional insect outbreak, of caterpillars or flies, is exploited by bulbuls. Lantana bushes are visited by Rosefinches. With the exception of the barbets and some White-eyes all these species travel in flocks.

(3) *Territoriality.* Territories may be held by individuals, or possibly by pairs Most of the common species showed site fidelity, individuals being repeatedly recaptured at the same net site throughout the year. Common species observed in aggressive territorial behaviour in the Autumn included the Greenish Warbler, the Blackbacked and Brown Shrikes, the Shama and the Pied Bushchat. Probably all Palaearctic migrants except the Rosefinch, the Hodgson's Tree Pipit and the Crowned Leaf Warbler are territorial. Individuals of four migrant species (the Blyth's Reed Warbler, the Greenish Warbler and the Rubythroat, and one Twobarred Warbler) returned for the 1977-1978 Winter (table 2) to the *identical* territory of the preceding Winter, (a Hodgson's Tree Pipit also returned).

Some resident species may hold territories as pairs. White-eyes were frequently captured and recaptured in twos. Tailor Bird pairs were regularly seen feeding, and calling together.

A special study was made of territoriality in the Greenish Warbler (Price, MS). It has been shown that territories vary several-fold in size and amount of available food. The quality of the individual (that is, its likelihood of survival) correlates with this. It is probable that most Winter territoriality is to ensure an

TABLE 3

SONG PERIODS FOR SELECTED SPECIES

	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	July
Bustard Quails*						– – – –	– – –	– – –	+ + + +	+ + +	+ + +
Orangebreasted Green Pigeon							+ + + +	+ + +	+ – – –	– – –	– – –
Emerald Dove						?	? + + +	+ + +	+ + + +	+ + +	+ + +
Baybanded Cuckoo[1]							+ + + +	+ + +	+ – – –	– – –	– – –
Plaintive Cuckoo[2]								– + +	+ + +	+ + +	– – –
Common Iora						– –	+ +	+ + + +	+ + +	+ + –	– – –
Spotted Babbler[3]	?	?		?			– –	+ + + +	+ + + +	– – –	– –
Yellowbreasted Babbler[4]	– –	– – –	– – –	– – –	– – –	– – –	– –	+ + + +	+ + + +	+ + +	– –
Brooks's Flycatcher	· – –	– + +	+ +	– – –	– – –	– – – +	+ + +	+ + +	+ + + +	+ + +	– – –
Whitethroated Fantail Flycatcher						– – +	+ + +	+ + + +	+ + –	– – –	– –
Ashy Wren Warbler	+ + +	– –				– – +	+ +	+ + + +	+ + + +	– – –	– –
Jungle Wren Warbler	+ +	+ + +	– – –	– – –	– – –	– +	+ + +	+ + +	+ + + +	+ + +	+ + +
Magpie Robin							+ +	+ + + +	+ + + +	+ + –	– – –
Shama	– –	+ +	+ +	– – –	– – –	– – – –	– + +	+ + + +	+ + + +	+ – –	– –
Pied Bush Chat	– –	– – –	– – –	– – –	– – –	+ + +	+ + +	– – –	+ + +		
Chestnutbellied Nuthatch						+ + +	+ + +	+ + + +	+ – –	– –	
White-eye						+	+ + +	+ + + +	+ + + +	– – –	–

– – – Song infrequent + + + song commonly heard

* The two species of Bustard Quail are not distinguished

[1] The "wee tee ti tee" call (see Ali & Ripley 1969)
[2] The "piteer" call (see Ali & Ripley 1969)
[3] The "he'll beat you" call (see Ali & Ripley 1971)
[4] The "chwonk chwonk" call (see Ali & Ripley 1971)

TABLE 4

THE PROPORTION OF BIRDS IN PRIMARY MOULT, AT THEIR TIME OF FIRST CAPTURE OVER THE STATED PERIOD. THE SAMPLE SIZE IS GIVEN IN PARENTHESES

Species	% Moulting*	Period Covered
Specckled Piculet	100(4)	30 Aug.-4 Oct.
Blackbacked Shrike	50(2)	,,
Common Iora	91(11)	,,
Redwhiskered Bulbul	100(57)	,,
,,	100(18)	20 Jul-1 Aug.
Redvented Bulbul	100(26)	30 Aug-4 Oct.
,,	58(19)	1 Jun-13 Jul.
Whitebrowed Bulbul	50(2)	30 Aug-4 Oct.
Spotted Babbler	100(11)	,,
Redfronted Babbler	90(10)	30 Aug-3 Nov.
Rufousbellied Babbler	88(16)	,,
Yellowbreasted Babbler	100(6)	,,
Yelloweyed Babbler	100(4)	30 Aug-4 Oct.
Quaker Babbler	47(17)	,,
Brooks's Flycatcher	73(11)	,,
Tailor Bird	62(21)	,,
Blackbird	50(8)	11 Oct-31 Oct.
Blackspotted Yellow Tit	58(12)	30 Aug-4 Oct.
White-eye	90(29)	,,
,,	63(8)	10 Jul-27 Jul.

TABLE 5

THE NUMBER OF PALAEARCTIC MIGRANTS IN EACH FIVE WEEK PERIOD EXPRESSED AS A PERCENTAGE OF MIGRANTS PLUS RESIDENT

	30 Aug-2 Oct.	3 Oct-6 Nov.	7 Nov-11 Dec.	12 Dec-15 Jan.	16 Jan-19 Feb.	20 Feb-26 Mar.	27 Mar-30 Apr.	1 May-4 Jun.	12 Jun-10 Jul.	3 Jan '78-7 Feb '78
% Migrants	5.4	23.3	21.8	19.4	15.7	23.5	21.8	4.1	1.5	20.9
Sample Size	330	322	288	257	261	289	321	197	135	179

TABLE 6

LONGEVITY RECORDS. FIGURES IN PARENTHESES REPRESENT TOTAL NUMBERS RINGED IN THE STATED YEAR. 1971 BIRDS ARE AT LEAST 6½ YEARS OLD, 1972 BIRDS AT LEAST 5½ YEARS OLD

Species	Number recaptured during 1976-1977 from:— 1971	1972
Plaintive Cuckoo	0(7)	1(5)
Pied Flycatcher Shrike	1(26)	0(12)
Large Wood Shrike	0(2)	2(8)
Common Wood Shrike	1(7)	0(?)
Blackheaded Cuckoo Shrike	1(10)	0(3)
Common Iora	3(48)	2(28)
Redwhiskered Bulbul	5(?)	3(220)
Redvented Bulbul	3(74)	2(83)
Redfronted Babbler	1(?)	0(20)
Rufousbellied Babbler	2(?)	0(16)
Yellowbreasted Babbler	2(21)	0(32)
Quaker Babbler	2(60)	3(80)
Greyheaded Flycatcher	0(15)	1(14)
Blacknaped Blue Flycatcher	1(21)	0(37)
Ashy Grey Wren Warbler	1(?)	0(?)
Tailor Bird	2(97)	1(26)
Greenish Warbler	2(?)	0(?)
Shama	1(33)	1(46)
Whitethroated Ground Thrush	1(19)	2(14)
Blackspotted Yellow Tit	2(77)	0(38)
White-eye	1(121)	0(57)

TABLE 7

THE TOTAL NUMBER OF SPARROWS CAPTURED IN NETTING SESSIONS IN THE VILLAGE OF LAMMASINGHI. THE NUMBER OF JUVENILES IN THE CATCH IS GIVEN IN PARENTHESES

Species	17 Sep	12 Oct	31 Oct	23 Nov	19 Dec	9 Jan	22 Feb	22 Mar	26 Apr	22 Jun	1 Feb '78	Total
House sparrow	14(4)	12(1)	4(0)	14(3)	8(2)	8(3)	15(7)	15(5)	6(3)	16(10)	10(3)	122
Tree sparrow	3(2)	4(1)	1(0)	—	2(0)	1(0)	2(0)	3(0)	6(0)	1(1)	—	23

adequate food supply (Davies 1976, Salomonsen and Balda 1976).

(4) *Permanent flocking.* Some Tits and Velvetfronted Nuthatches remain in small flocks (probably family parties) throughout the Winter. Babblers flock and are repeatedly caught in a restricted area. Two species, the Quaker Babbler and the Redfronted Babbler associate interspecifically. The Large Wood Shrike associates in flocks which wander over a large area. Probably all these species have a restricted home range or territory. Presumably it is kin which flock together, and favoured if the increased benefit gained by juveniles (in not being excluded from their natal area) is not offset by too great a loss for adults. The more omnivorous species appear to adopt this strategy, and it may be that dominance hierarchies are more efficient when feeding on fruit than insects. Flocking may also allow an extended period of parental care.

Mixed insectivorous flocks were very rarely seen during the Winter period, although occasionally seen in the wetter 1977-1978 Winter and in wetter areas, e.g. at Gudem. They are similar in composition to the large post-breeding flocks, with much reduced numbers of White-eyes. They probably form facultatively as birds vacate territories to join them. This was observed in the case of a pair of Grey-headed Flycatchers, which flew over 50 metres from the area they were normally resident in to forage with a small flock for ten minutes on the 9th January 1978. It is suggested that mixed feeding flocks are rare because many foliage gleaners are unable to maintain an insectivorous diet as Arthropod levels drop (see below).

The impact of Palaearctic migrants

Apart from the Rosefinch all Palaearctic migrants are primarily insectivorous and feed on dispersed food sources. None were seen at clumped fruit or nectar sources, despite large assemblages of birds, including resident warblers, at the *Bombax* trees in February. In contrast to Karr's (1976a) statements directed mainly at the Neotropics, migrants do not in general exploit superabundant food sources, which simply do not exist in mid Winter. In early November large numbers of earthworms came to the surface, and formed a superabundant food. This was exploited by passage thrushes—the Orangeheaded and Pied Ground Thrushes—as well as resident thrushes (the Whitethroated Ground Thrush and Blackbird), and the Spotted Babbler.

It appears that many overwintering migrants should be in direct competition with residents. However, I postulate that seasonal changes in climate are far more important than the presence of migrants in influencing the behaviour of residents in agreement with most recent studies (see Chipley 1976, for a review).

In the case of the Greenish Warbler, the most abundant Winter visitor, it is suggested that this species is a "generalist" foliage gleaner and thus able to maintain an entirely insectivorous diet. Many of its potential competitors—the Iora, babblers, bulbuls, tits and White-eyes overlap completely with it in foraging height and habitat distribution (Price 1978), but all, with the exception of the Iora include large amounts of fruit and nectar in the diet (Ali and Ripley, 1968-1974, and personal observations of foraging behaviour and faecal analysis). These are considered to be "specialist" insectivores, able to find sufficient numbers of large insects in the wet season to raise a brood, but supplementing their own diet at all times with vegetable matter. Resident warblers (the Tailor Bird and Wren-Warblers) separate from the Greenish Warbler by foraging height (they are generally con-

fined to the first two metres above ground) and take nectar. It appears possible that the Greenish Warbler is prevented from breeding by competition (although difficult to demonstrate), but unlikely that it has a significant affect on the overwinter behavior of resident species.

Final Note

Forest destruction is having a serious impact on bird life in the Eastern Ghats. It is clear that there is insufficient habitat for the large numbers of some species of Palaearctic migrants to over winter successfully (particularly, in this study, the Greenish Warbler). Breeding populations of many forest dwelling species are being reduced, in one case (the Little Spiderhunter) to near extinction. There is, however, some influx of species from the coastal plain, as the habitat comes to resemble this area. More work is needed even to arrive at a full species list for the region. Field studies on the ecology of the tropical forest are needed so that suitable conservation projects can be proposed before all is destroyed.

ANNOTATED LIST

All species identified on the study area at Lammasinghi are listed below, following the order of Ripley (1961). Whistler and Kinnear (1932-1939), Abdulali (1945, 1953) and Price (in press) provide notes on species occurring elsewhere on the Ghats and on the coastal plain.[1] An appendix lists additional species recorded within ten kilometres of Lammasinghi.

Notes are designed to give 1) an idea of the status of each species; 2) observations that differ from or are additional to, those given by Ali and Ripley (1968-1974); 3) Provide any direct evidence for time of breeding. The list should be read in conjunction with part I of this paper, particularly with reference to tables 1 and 2 and Figures 1 and 10.

As noted previously the list is incomplete, especially with respect to the larger non passerines, to which I paid little attention.

Paddy bird. **Ardeola grayii.**
Occasionally seen, especially between December and February on the paddy.

Blacknecked stork. **Xenorhynchus asiatieus.**
One or two birds occasionally seen in January and February.

Blackwinged kite. **Elanus caeruleus.**
Resident.

Pariah kite. **Milvus migrans.**
One or two birds regularly seen over the village through the year.

Shikra. **Accipiter badius.**
Noted between January and July.

Crested goshawk. **Accipiter trivirgatus.**
Resident, noted in display flights in March.

Crested serpent eagle. **Spilornis cheela.**
Regularly seen and heard.

Black eagle. **Ictinaetus malayensis.**
Regularly seen.

Kestrel. **Falco tinnunculus.**
One on the 11th April, also elsewhere, e.g. at Solabum on the 15th January.

Painted bush quail. **Perdicula erythorhyncha.**
Resident. Two adults with four juveniles captured on the 25th January. The juveniles were going through wing moult.

Red spurfowl. **Galloperdix spadicea.**
Common resident.

Red junglefowl. **Gallus gallus.** Common resident.

Indian peafowl. **Pavo cristatus.**
Seen or heard on three occasions at Lammasinghi where it has been mostly short out. Commoner around Merripakala.

Button quail. **Turnix tanki.**

Common bustard quail. **Turnix suscitator.** Both *Turnix* species are common in the area. See song chart.

Redwattled lapwing. **Vanellus indicus.** Occasionally seen in January and February; breeds further west on the plateau.

Orangebreasted green pigeon. **Treron bicincta.**

Summer visitor, recorded between the 2nd February and the 13th July. (Figure 10). In 1978 a few birds present in January. Flocks arrive and are common from mid March to mid April on fruiting trees, after which there is dispersal for breeding. A captured bird laid an egg on the 2nd May.

Rufous turtle dove. **Streptopelia orientalis.** Up to four individuals recorded at Lammasinghi between December and February. More common elsewhere in the Ghats, e.g. at Gudem, where it probably breeds.

Spotted dove. **Streptopelia chinensis.** Resident; courtship, fighting and song most pronounced between June and September. Up to fifty birds flocking on stubble in the Winter months.

Emerald dove. **Chalcophaps indica.** Resident, commoner in the wetter forests between Gudem and Merripakala.

Blossomheaded parakeet. **Psittacula cyanocephala.**

Parties of up to six birds regularly seen throughout the year. Larger parties recorded further west on the more open areas, e.g. around Chintapalli.

Indian lorikeet. **Loriculus vernalis.** Common resident in the area, up to 40 birds noted at Eucalyptus blossoms during January.

Indian cuckoo. **Cuculus micropterus.** Single birds heard calling at dawn on the 19th April and 4th May.

Cuckoo. **Cuculus canorus.** Heard on most days during May. Two birds were seen being mobbed on the 19th May by bulbuls and white-eyes. The species must breed in the area (see also Neavoll 1968).

Small cuckoo. **Cuculus poliocephalus.** Recorded on passage four times in October. One was also captured on the 5th May 1971.

Baybanded cuckoo. **Cacomantis sonneratii.** Probably resident, although inconspicuous and silent between November and January. There are two distinct calls—a rising crescendo "pi pi pee...pi pi pee" as described for the Plaintive Cuckoo by Ali and Ripley (1969), and the four noted whistle "wee tee ti tee". The rising crescendo, identical to that given by the Plaintive Cuckoo is heard from January right through to October, most commonly between March and May. The "wee tee ti tee" was first heard on the 7th February, and was given late into the night in April, having died out by mid June. See Figure 10.

Plaintive cuckoo. **Cacomantis merulinus.** Summer visitor, first record on the 25th February (Figure 10). The "piteer" call first heard at the beginning of April, commonly between April and June. On the 7th July a juvenile was trapped. The rufous phase is fairly common. The Plaintive Cuckoo is commoner than the Baybanded cuckoo during the breeding season. The relationship between the two species, in view of one of their songs being identical deserves further study. A between-species chase was noted in early April.

Koel. **Eudynamys scolopacea.** A female captured on the 25th October and heard several times during March and April. Very common on the coastal plain.

Large greenbilled malkoha. **Rhopodytes tristis.**
A single bird trapped on the 25th January 1978, although there are several unconfirmed sight records for January and February 1977. A range extension for the species.

Crow pheasant. **Centropus sinensis.**
Regularly heard from January onwards. Resident.

Scops owl. **Otus scops.**
A single bird trapped on the 24th January, the only record for Lammasinghi.

Collared scops owl. **Otus bakkamoena.**
Probably resident.

Indian jungle nightjar. **Caprimulgus indicus.**
A single bird captured on the 21st January 1978, the only record. Common on the coastal plain.

Longtailed nightjar. **Caprimulgus macrurus.**
Resident, one bird captured in July, recaptured the following January. See also Figure 10.

House swift. **Apus affinis.**
200 passed over the village on the 26th May. Breeds commonly elsewhere, e.g. at Sileru.

Palm swift. **Cypsiurus parvus.**
Throughout the Winter season thousands undertake a daily migration from roosts in Palm trees on the coastal plain. This migration noted low over Lammasinghi in the mornings in September and in the evenings between January and March. One count on February 1st totalled 8,500 passing over between 1615 and 1730 hours. Between April and June small flocks were occasionally seen fleeing storms. Several pairs probably bred in the area.

Crested tree swift. **Hemiprocne longipennis.**
Resident, a maximum of 34 birds seen circling overhead in September.

Malabar trogon. **Harpactes fasciatus.**
Resident in the mature forest throughout the Ghats area.

Whitebreasted kingfisher. **Halcyon smyrnensis.**
Seen on about ten occasions through the year above the paddy.

Chestnut-headed bee-eater. **Merops leschenaulti.**
Up to eight birds seen from the 12th January through February. Last record on the 23rd March. An extension of the wintering range: recorded also in January 1978.

Small green bee-eater. **Merops orientalis.**
Singles and a small party seen in mid-October, (when the bird was abundant on the coastal plain at the foot of the Ghats) and at the end of March.

Bluebearded bee-eater. **Nyctyornis athertoni.**
Conspicuous and noisy between April and August. Rare in January and February when birds probably moved to lower elevations.

Hoopoe. **Upupa epops.**
Mainly a summer visitor, though one noted on the 1st November. Influx in January, some song from February onwards, notable during April. Two nests with young discovered in the last week of April, and a juvenile captured on the 9th May. No birds present after mid June. (Figure 10).

Indian pied hornbill. **Anthracoceros malabaricus.**
A pair heard and see during March-April. Fairly common in the Gudem—Merripakala region.

Large green barbet. **Megalaima zeylanica.**
Common resident.

Coppersmith. **Megalaima haemacephala.**
Common resident. Individuals of both species of barbet captured in April with well developed brood patches.

Wryneck. **Jynx torquilla.**
Recorded between the 7th October and the 7th April. Two birds regularly recaptured through this period.

Speckled piculet. **Picumnus innominatus.**
Regularly seen; a family party captured on the 25th April.

Rufous woodpecker. **Micropternus brachyurus.**
Occasionally seen between January and July.

Large yellownaped woodpecker. **Picus flavinucha.**
Not recorded during the study period. An individual was trapped in March, 1971 and the species has been recorded elsewhere in the Ghats (Hussain *et al.* 1976).

Lesser yellownaped woodpecker. **Picus chlorolophus.**
Occasionally seen between January and July, regularly heard calling from mid February onwards.

Fulvousbreasted woodpecker. **Picoides macei.**
Regularly seen; on the 5th July a juvenile being fed by a female.

Yellowfronted pied woodpecker. **Picoides mahrattensis.**
Seen on about six occasions during the year, moving into the area notably towards the end of the dry season. Commoner in open woodland further west on the plateau.

Pygmy woodpecker. **Picoides nanus.**
Regularly seen.

Larger goldenbacked woodpecker. **Chrysocolaptes lucidus.**
Two or three pairs regularly seen and heard through the year. One pair at nesting hole on the 26th May.

Indian pitta. **Pitta brachyura.**
Three passage records only: the 2nd and 19th October and the 25th April.

Redrumped swallow. **Hirundo daurica.**
Seen in flocks of up to 100 during the Winter, often associated with the Palm Swift. Immediately after the first rains, on the 26th February, a pair began nest building, but they had not bred by mid April. Eight caught on the 5th February 1978 were all in primary moult.

Baybacked shrike. **Lanius vittatus.**
A single bird seen on the 22nd of February. Common on the coastal plain; not recorded elsewhere in the Ghats, (but see Whistler and Kinnear 1933).

Rufousbacked shrike. **Lanius schach tricolor.**
Resident, singing only noted between December and February. Juveniles first noted in early July. Two of the individuals trapped had grey "*erythronotus*" feathers admixed in the crown and back.

Brown shrike. **Lanius cristatus.**
An adult trapped on the 22nd September. The main arrival, entirely of juveniles was in the first two weeks of October, and territories were established. Conspicuous until the middle of November when birds virtually disappeared. Because of the changed foraging habit (from typical shrike like exposed perching to feeding within undergrowth) it is not clear how much, if any, of this disappearance was due to dispersion. A return passage noted in the last two weeks of April; all birds in freshly moulted plumage. In January 1978 more birds were present on the study area than in January 1977: Elsewhere on the plateau in January 1978, two adults were seen.

Golden oriole. **Oriolus oriolus.**
Two on the 22nd March, the only ones observed. Common on the coastal plain.

Blackheaded oriole. **Oriolus xanthornus.**
First noted in association with *Bombax* blossoms in mid February. A pair regularly seen

and heard during the following six months of the year. Common resident in the wetter forest areas, e.g. near Gudem, and observed at Lammasinghi in January 1978.

Grey drongo. **Dicrurus leucophaeus.**
Clearly a resident in the area. Particularly conspicuous around *Bombax* trees in February and March. One pair occupying a large mango tree in the secondary growth area was seen chasing Jungle Crows and Crow Pheasants between the 15th May and the 24th June. On the 24th May a bird was seen carrying a faecal sac from the tree, and on the 2nd June a free flying juvenile noted. One individual captured on the 1st October was going through wing moult.

Whitebellied drongo. **Dicrurus caerulescens.**
Two on the 14th January and one on the 12th January, 1978. Commoner on the coastal plain.

Bronzed drongo. **Dicrurus aeneus.**
Resident in the Ghats, especially common in the wetter forests, e.g. from Gudem to Merripakala. Occasionally recorded at Lammasinghi.

Ashy swallow shrike. **Artamus fuscus.**
Recorded on the 27th November and the 22nd December only. Breeds at Thajangi Lake, and common on the coastal plain.

Greyheaded myna. **Sturnus malabaricus.**
First recorded in mid February; subsequently flocks of up to 100 birds seen going to roost. Dispersal for breeding during March. A few pairs bred in the area between April and May. Small flocks seen between June and July, by the end of which birds had disappeared. (Figure 10).

Brahminy myna. **Sturnus pagodarum.**
The common *Sturnus* of the coastal plain. One or two pairs arrived with the grey headed myna and bred in the area. Noted singing in April, and with young in the nest on the 31st May. (Figure 10).

Pied myna. **Sturnus contra.**
Seen occasionally in January and February at Lammasinghi; this species is fairly common in the dry arable areas of the plateau.

Common myna. **Acridotheres tristis.**
Rarely seen at Lammasinghi between January and March. Common on the coastal plain and on drier areas of the plateau to the west.

Jungle myna. **Acridotheres fuscus.**
Occasionally seen throughout the year. Numbers increase from January, and birds were regularly seen in March and April. Young in the nest on the 31st May. Decrease through July. (Figure 10).

Hill myna. **Gracula religiosa.**
Regularly seen in the mature forest; commoner in the evergreen forest around Merripakala.

Himalayan tree pie. **Dendrocitta formosae.**
Resident, particularly conspicuous in September and after July when groups of birds go noisily to roost.

Jungle crow. **Corvus macrorhynchos.**
Birds seen going to roost down the ghatface regularly from September to January (182 maximum recorded on the 14th September). Only 54 noted in mid January, when some birds were roosting on the plateau. Birds in display flight in March; food being carried to young in the nest on the 5th April. Family parties seen from May 5th to the end of June, after which they break up.

Pied flycatcher-shrike. **Hemipus picatus.**
Resident.

Large wood shrike. **Tephrodornis gularis.**
Regularly but infrequently seen in parties of up to seven birds in the Winter months (up to

10 after breeding). It is apparent that these flocks wander over a large area; one individual was captured in nets two kilometres distant, in separate months.

Common wood shrike. **Tephrodornis pondicerianus.**

Single birds infrequently seen in secondary growth area, or in the company of mixed feeding flocks in the deciduous woodland. Two seen chasing and displaying on the 9th March.

Large cuckoo-shrike. **Coracina novaehollandiae.**

Only seen on three occasions through the study period. Two individuals trapped in March, 1972. The species is commoner elsewhere, e.g. between Thajangi and Bussalkert.

Dark grey cuckoo-shrike. **Coracina melaschistos.**

An uncommon Winter visitor to the area, occasionally recorded between December 20th and March 22nd. In January, 1978 one bird noted chasing a female Blackheaded cuckoo shrike.

Blackheaded cuckoo shrike. **Coracina melanoptera.**

Although clearly a resident in the Ghats (Figure 10), captures at Lammasinghi were confined to October and November and March and April. Of the nine birds trapped, eight were males. No birds seen in May and June although males were singing near Downeru at the foot of the Ghats on the 31st April. During July two or three males were present and singing.

Scarlet minivet. **Pericrocotus flammeus.**

Display flights seen from February to May, with males chasing each other and females. One nest was being built at the end of May by the male alone during 90 minutes of observation.

Rosy Minivet. **Pericrocotus roseus.**

Summer visitor. First arrival on the 2nd March. Fairly common during April to June and clearly bred in the area (Figure 10). Post breeding birds are often associated in flocks with the Small Minivet: One premigratory flock of over 8 birds seen on the 20th July. Two males were seen on the 23rd January 1978. See Figure 10.

Small minivet. **Pericrocotus cinnamomeus.**
Flocks of up to six birds commonly seen throughout the year.

Common iora. **Aegithina tiphia.**

Common, but widely dispersed and inconspicuous during the mid Winter months. In the mature forest it remains in the canopy and was never captured. First bird in full breeding plumage was noted on the 7th March. The "see me please" song is first heard at the end of January (see Figure 12). Many second year birds did not come into full breeding plumage: males captured on the 29th May and 14th June had only the central tail feathers replaced. It is not known if they bred. One nest with young on the 2nd June, another being built on the 29th May.

Goldfronted chloropsis. **Chloropsis aurifrons.**
Regularly seen, notably vociferous around nectar sources in the Winter months. The call note of several individuals in this area is identical to that of the Grey Drongo. Song noted in September and between March and July included imitations of the Scarlet Minivet, Blacknaped Blue Flycatcher (call note), Redwhiskered Bulbul and Large Wood Shrike. On the 6th July a bird was captured with a well developed brood patch.

Blackheaded yellow bulbul. **Pycnonotus melanicterus.**

Common throughout the mature forests, particularly in the wetter areas, e.g. near Gudem.

One bird captured on the 13th October had flecks of ruby red on the breast—identical coloration to the red throat of the subspecies *guiaris* of the south Indian hills.

Redwhiskered bulbul. **Pycnonotus jocosus.** Abundant, building observed from March to May, first juveniles noted in early May.

Redvented bulbul. **Pycnonotus cafer.** Abundant, eggs noted from mid April to the end of June. Particularly noisy in the April dawn chorus.

Whitebrowed bulbul. **Pycnonotus luteolus.** Resident in small numbers in secondary growth, commoner on the plains. Song noted from at least early January.

Spotted babbler. **Pellorneum ruficeps.** Resident, in pairs and small parties. The "he'll beat you" call of Ali and Ripley common in April and May, allows contact over at least 200 metres. A trapped bird had a well developed brood patch on the 25th April.

Scimitar babbler. **Pomatorhinus schisticeps.** Regularly heard through the year. A bird captured on the 25th March, 1972 laid an egg in the hand.

Redfronted babbler. **Stachyris rufifrons.** Calling throughout the year particularly during April and May. Often associated with Quaker Babblers.

Rufousbellied babbler. **Dumetia hyperythra.** Seen in parties of up to 11 birds from September to March, although inconspicuous from January—March. On the 20th July two nests were discovered within 20 metres of each other, and may have been from pairs splitting from the same party. At this time post breeding groups were seen elsewhere.

Yellowbreasted babbler. **Macronous gularis.** More arboreal than the other small babblers, seen in small parties or singly. The call note is heard throughout the year, particularly from April to July (Figure 12). Young fledged from a nest on the 13th July. The commonest babbler in the thick forest at Merripakala.

Yelloweyed babbler. **Chrysomma sinense.** Regularly seen in the secondary growth area; commoner in Lantana especially elsewhere in the plateau.

Jungle babbler. **Turdoides striatus.** Sisterhoods only seen between the 11th January and the 2nd February. Apparently bred in the area-individuals were recorded from February to August, sentinel 'checking' noted in April, and a juvenile seen in May. Commoner elsewhere in the plateau.

Quaker babbler. **Alcippe poiocephala.** Common in pairs or small flocks often associated with *Stachyris* or *Macronous*. The song recorded by Ali and Ripley (loc. cit.): "a quavering trill of four notes" is heard throughout the year, and is the most prominent song of the April dawn chorus. In addition there is an unrecorded song, consisting of similar quality (but many more) notes uttered in a long down cadence accompanied by chattering from the female. Nest building was observed in the last two weeks of May and also in early July. In May some birds were still going through the complete prenuptial moult. Of interest is the record of two birds trapped on the 11th April 1971 and recaptured together three times during the study period.

Brown flycatcher. **Muscicapa latirostris.** A pair seen first on the 31st March, and seen on subsequent weeks in April chasing each other through the tree tops. Individuals captured on the 20th and 27th of April. Although not seen after this they may well have bred in the area. A single bird noted on the 13th July.

Rufoustailed flycatcher. **Muscicapa ruficauda.** A single passage record of a bird trapped on the 4th April.

Redbreasted flycatcher. **Muscicapa parva.** Widespread Winter visitor in fairly small numbers. Recorded between the 18th October and the 16th April. Notable passage in the last week of March and first two weeks of April; several males were trapped in full breeding plumage.

Whitebrowed blue flycatcher. **Muscicapa superciliaris.**

Widespread but sparingly distributed Winter visitor to the whole of the Ghats area. First noted in the first week of November, last recorded on the 29th March. Males (both subadult and adult) are more common, and easily identified by the "whi churr" call note. The only female noted was one trapped on the 16th December. Adult males observed, and one trapped, had no white in the tail, and a very thin white supercilium, placing them close to the subspecies *aestigma* (Whistler and Kinnear 1933).

Brooks's flycatcher. **Muscicapa poliogenys vernayi.**

A common resident. Whistler and Kinnear (1933) identified this species as *poliogenys* (c/s *Muscicapa tickelliae*) because of the brown juvenile plumage and dull female, and measurements support this. However adult males are very blue, and the song closely resembles that of the Tickell's Flycatcher heard in Borivli National Park near Bombay. The situation needs further investigation. There is clearly only one species present here, and for the present the range of Tickell's Blue Flycatcher should be adjusted accordingly. Territorial behaviour and song noted in both early Autumn and in April and May (see Figure 11B). Both male and female were singing around recently fledged young as I approached on the 1st June.

Bluethroated flycatcher. **Muscicapa rubeculoides.**

A passage migrant, recorded between the 14th and 28th October and the 20th March and 4th April, (see Figure 10).

Verditer flycatcher. **Muscicapa thalassina.**

Recorded between the 3rd November and 22nd February. A Winter visitor in small numbers.

Greyheaded flycatcher. **Culicicapa ceylonensis.** Resident, one of the commonest species in the wetter forests elsewhere in the Ghats. Capture of a recently fledged juvenile on the 13th July is the first proof of breeding for the species in the Ghats.

Whitebrowed fantail flycatcher. **Rhipidura aureola.**

Seen on several occasions between September and November in a deciduous forest area, and again in February and March and in May and June when in full song.

Whitethroated fantail flycatcher. **Rhipidura albicollis.**

Resident in secondary growth areas. Nest building noted on the 10th April.

Blacknaped blue flycatcher. **Monarcha azurea.** Common breeding bird but only rarely recorded during December and January, although more in evidence during January of 1978, apparently facultatively moving to lower elevations during the dry season (Figure 10). A previously unrecorded song "a ringing chew chew chew", resembling the Tailor Bird was heard on the 1st June and on several occasions in the two weeks subsequently. This song was also heard by Mr. S. A. Hussain of the Bombay Natural History Society and myself in Borivli National Park, near Bombay on the 27th July.

Paradise flycatcher. **Terpsiphone paradisi.** Several individuals were captured in March, 1972. Not recorded at Lammasinghi during the study period, although two pairs, probably breeding, were located near the foot of the Ghats near Downeru on the 30th April, and an immature was seen three kilometres away on the plateau on July 10th.

Ashy-grey wren-warbler. **Prinia hodgsonii.** Inconspicuous, in parties or singly throughout the dry season. Song prominent from March onwards, and in January 1978.

Ashy wren-warbler. **Prinia socialis.**
The commonest wren-warbler. During the dry season wanders into forest clearings from the secondary growth. Food being carried to young in the nest seen in September and in June.

Jungle wren-warbler. **Prinia sylvatica.**
Common elsewhere, on the drier, more scrubby areas of the plateau. One pair was still breeding in October: and independent juveniles noted on the 6th July. In addition to the "sihoot" song noted by Ali and Ripley (loc. cit.), (the note repeated once per second in runs lasting up to thirteen minutes), there is a second song "weeoch" repeated 15-20 times at a rate of two per second, followed by a pause and repeats of the sequence. A male watched for the whole day on the 18th September, at a time when his mate was laying spent 85 minutes in song; dividing his time equally between the two song types. Long runs of song were confined to the morning. The "sihoot" song more conspicuous during April and May.

Tailor bird. **Orthotomus sutorius.**
Common resident, seen individually or in pairs. On the weekly post-dawn walk approximately twice as many birds were calling during the wet season (June) compared with the dry season (January).

Grasshopper warbler. **Locustella naevia.**
Two records only: on the 31st January and on the 5th February, 1978.

Thickbilled warbler. **Phragmaticola aedon.** Scarce winter visitor. Recorded only between 27th January and the 28th April. One individual was known to have stayed in the area during this time.

Blyth's reed warbler. **Acrocephalus dumetorum.**
First arrivals on the 21st October, with an influx in the beginning of November, having gone through a complete moult further north in the peninsula (Gaston 1975). *At least* half of these birds maintained territories throughout the Winter. Departure at the end of April. There was an influx of birds in mid March (see Figure 10). The last record was on the 16th May. Some song was noted just prior to departure.

Tickell's leaf warbler. **Phylloscopus affinis.**
An adult and juvenile captured together on the 14th November are the only records.

Yellowbrowed leaf warbler. **Phylloscopus inornatus.**
Widespread winter visitor to the whole plateau.

Largebilled leaf warbler. **Phylloscopus magnirostris.**
Commonly recorded on passage between the 29th September and the 21st October and the 6th April and the 27th April. Restricted to the undergrowth of the mature forest, in contrast to the habitats occupied on its breeding and wintering grounds. (Ali and Ripley, loc. cit.)

Greenish warbler. **Phylloscopus trochiloides.** The subspecies *ludlowi* is an abundant Winter visitor, first recorded on the 30th August. Arrival continues until the third week of October. Departures are over the last two weeks of April and the first week of May; birds were

recorded as late as the 23rd June. All individuals are territorial. Song is heard regularly during territory establishment (from both sexes)and prior to departure (probably from males only). Song is also heard occasionally through the Winter; there is evidence that this involves an attempt by one bird to expand its territory at the expense of another as in Grey Wagtail (see below, Price, 1978). 10 out of 15 (66%) of the colour ringed birds holding territories not disturbed by felling operations returned in 1978. The subspecies *viridanus* was recorded occasionally during passage months, and a bird closely resembling the subspecies *nitidus* trapped on the 8th November.

Large crowned leaf warbler. **Phylloscopus occipitalis.**
Uncommon Winter visitor.

Greyheaded flycatcher warbler. **Seicercus burkii.**
A record on the 25th March 1972 and one from the 4th November. An uncommon Winter visitor, apparently at the southern edge of its winter range.

Rubythroat. **Erithacus calliope.**
Widespread winter visitor to the Ghats, recorded at Lammasinghi between the 19th October and the 2nd April (Figure 10). Some song in early November, also heard in January, 1978.

Bluethroat. **Erithacus svecicus.**
A juvenile was trapped on the 16th December. This bird winters at low densities on the plateau in the wetter open areas.

Bluechat. **Erithacus brunneus.**
Recorded on passage in the last two weeks of October, the last week of April and the first week of May. A few birds over winter, there being records for all Winter months (Figure 10).

Magpie robin. **Copsychus saularis.**
Resident and summer visitor. Birds come into song in March, most song is heard in April, the amount per bird decreasing during May (Fig. ures 10 and 12). First independent young seen on the 26th May. Adults in mid June are inconspicuous, either moulding or having departed. Wintering birds are confined to the area of secondary growth, although some breeding takes place in the moist deciduous forest.

Shama. **Copsychus malabaricus.**
Resident. See Figure 11A. In June it is the only conspicuous early morning songster. First young noted on the 31 May.

Stone chat. **Saxicola torquata.**
One specimen captured in March 1971. Winters in small numbers on the wetter, more open areas, higher on the plateau.

Pied bush chat. **Saxicola caprata.**
Resident and Summer visitor. Pairs and single females held territories through the Winter. There was an influx of males and an increase in song through January and February. First fledged young noted on 1st May. Independent young in June when adults are inconspicuous. The only time song was noted from October to December was between two males; one intruding into an established territory.

Indian Robin. **Saxicoloides fulicata.**
Only two records from Lammasinghi during this study although it was recorded commonly in April 1972. More common elsewhere on the plateau and abundant on the coastal plain.

Blueheaded rock thrush. **Monticola cinclorhynchus.**
Four records from the last week of October, one from November, two each from January and February and five from March. All November to February records are of males. Noted in 1971, 1972 and 1978 also. This ex-

tends the Winter range of this species south east from Madhya Pradesh.

Blue rock thrush. **Monticola solitarius.**
A single sight record on the 14th October. This species winters on the rocky peaks above 3,000 feet elsewhere in the Ghats, e.g. near Solabum.

Pied ground thrush. **Zoothera wardii.**
A female on the 6th October, and males on the 27th October and 6th April are the only records. Passage migrant.

Orangeheaded ground thrush. **Zoothera citrina citrina.**
Resident, particularly common in the undergrowth of the moister mature forests. Infrequent songster. A notable capture was that of a pair ringed together as adults on the 11th May 1972 and recaptured together on the 27th April 1977.

White's mountain thrush. **Zoothera dauma.**
Recorded on the 31st March, 6th and 13th April only, extending the wintering range south from Sambalpur in Orissa.

Tickell's thrush. **Turdus unicolor.**
Recorded only on three occasions in the second two weeks of November. Previously recorded in the area in February (Whistler and Kinnear 1932) and two small flocks (c. 15 birds each) noted in January, 1978 may have been of this species.

Blackbird. **Turdus merula.**
Resident, particularly common elsewhere in "shola type" forests in the Ghats. There was an influx into the area in November to feed on large numbers of earthworms that came to the surface.

Blackspotted yellow tit. **Parus xanthogenys.**
Birds may remain as pairs throughout the year. Song and display first noted in January, accompanied by dispersal mainly of females. Maximum song and nest building in May. Family parties noted in July and September and a few parties of up to five birds noted throughout the Winter months.

Chestnutbellied nuthatch. **Sitta castanea.**
Resident, singly or in pairs outside the breeding season.

Velvetfronted nuthatch. **Sitta frontalis.**
Resident, invariably seen in pairs or parties of up to five birds outside the breeding season. A previously unrecorded behaviour is that of vigorous wing flapping, commonly seen on tree trunk faces, apparently attempting to flush insects.

Hodgson's tree pipit. **Anthus hodgsoni.**
Winter visitor. Noted from the 30th October to the 19th April, (Figure 10). Particularly common in January, when loose flocks of up to 30 birds recorded. Generally confined to the secondary growth area, occasionally seen within the forest.

Forest wagtail. **Motacilla indica.**
Recorded on passage between the 19th September and 24th October when up to four birds joined the Grey Wagtail roost. Singles on passage on the 1st and 27th April.

Grey wagtail. **Motacilla caspica.**
Present at least from the 26th August to the 18th April. During September and October large flocks, presumably containing many passage birds were recorded at roost. 150 birds roosting in a large *Ficus* on the 14th September increased to 680 on the 19th September. A decrease in October was accompanied by an increase in another *Ficus* to a maximum of 720 present on the 25th October.

Birds arrived at the roost up to one hour before entering it, in parties of up to 30 individuals, and departed in flocks of five to 470, flying west over the plateau. No feeding flocks

were ever noted. Over wintering birds are territorial during the daytime although roosting together. About 35 individuals were regularly recorded at roosts between November and February. Two birds holding adjacent territories along a road were colour ringed. These were seen displaying and singing at each other on 11th December, after which one bird disappeared. The other then occupied both territories until the beginning of April and returned to them over the 1977-1978 Winter.

Thickbilled flowerpecker. **Dicaeum agile.**
Resident, less common than Tickell's Flowerpecker. There is a rambling song of the general tone of the Ashy-grey Wren Warbler, containing mainly mixed up call notes; heard on several occasions through the year.

Tickell's flowerpecker. **Dicaeum erythrorhynchos.**
Common, the most abundant species in the dry deciduous forest on the hill tops.

Purplerumped sunbird. **Nectarinia zeylonica.**
Common, breeding mainly early in the year. One pair noted with three nesting attempts (all destroyed) between the 9th March and 27th April.

Purple sunbird. **Nectarinia asiatica.**
Approximately as common as the Purplerumped Sunbird; far more common elsewhere in the Ghats in the higher forested areas. Only a single male seen in breeding plumage during September-October, main breeding period in the early months of the year.

Yellowrumped sunbird. **Aethopyga siparaja.**
A male recorded at *Eucalyptus* flowers during the first week of January extending the Winter range south from Orissa. In January 1978 four males (one trapped) were seen between Gudem and Merripakala. It should be noted that the yellow rump is completely obscured in the field during the Winter by an overgrowth of green flank feathers.

Little spiderhunter. **Arachnothera longirostris.**
Captured in March 1971 (Raju and Selvin 1971) and in March 1972. Only noted during this study on 19th September. Elsewhere in the Ghats noted along watercourses between Gudem and Merripakala on the 14th April and near Thajangi on the 12th January 1978.

White-eye. **Zosterops palpebrosa.**
Abundant, resident. Pairs or individuals are regularly recaptured at the same net site throughout the year. Large post-breeding flocks (up to 50 birds) are seen at fruiting trees and as the nucleus to mixed feeding flocks in the mature deciduous forest. In November these flocks break up, and many small flocks of up to 15 birds influxed into the secondary growth area. Small flocks were seen throughout the Winter period at nectar sources. No flocks seen in April and May. First nest building observed on 11th March. Several nests with eggs located at least up to July 3rd. Family parties begin to appear in mid June.

House sparrow. **Passer domesticus.**
Present in all villages.

Tree sparrow. **Passer montanus.**
First noted at Lammasinghi in April 1972 (Raju and Price 1973). An extensive survey of neighbouring villages was undertaken, in an attempt to determine the status of the Tree Sparrow in the Eastern Ghats. Just one individual was noted at Solabum, and a breeding population discovered at Bussalkort. Two nets were placed in Lammasinghi village for a morning each month (table 7). The state of birds in the hand and direct observation shows that the Tree Sparrow has a restricted April to June breeding season, while the House Sparrow breeds throughout the year. Small post-breeding flocks during July and August

were noted on the edge of the village. It is estimated that the population of Tree Sparrows at Lammasinghi is less than 200, and the total population size in the Eastern Ghats may be less than 500 and decreasing to extinction. Apparently this is the only place in the world where two species of *Passer* breed side by side in thatched roofs. There is an unconfirmed sight record of possible hybrid birds at Bussalkort.

Baya. **Ploceus philippinus.**
First recorded on the 15th June. Several pairs nested beside the paddy fields. The species was abundant at Lammasinghi in March 1972.

Green munia. **Estrilda formosa.**
Small parties of between four and eight birds seen on six occasions during May. Larger flocks noted in January at Gudem and during March and April near Thajangi.

Whitebacked munia. **Lonchura striata.**
Seen throughout the year; in September, April and May in flocks of up to 40 birds.

Jerdon's munia. **Lonchura kelaarti.**
Noted particularly through the Winter months when flocks of 20-30 birds may be seen feeding in litter on the edge of the deciduous forest. Rarely recorded between April and July.

Spotted munia. **Lonchura punctulata.**
Several pairs breeding and commonly seen between September and November. Only occasionally recorded between January and May.

Common rosefinch. **Carpodacus erythrinus.**
Recorded between the 19th November and the 9th April (Figure 10). The influx into the Eastern Ghats region probably occurs earlier; two birds were nearing completion of full moult on the 16th and 23rd December. Flocks of up to 150 birds seen at Gudem. In March 1972, 200 individuals were captured at Lammasinghi when large stands of *Lantana*—a favourite food source—were present.

Summary

This paper reports on the results of a mist netting and observational study on the birdlife at one locality in the Eastern Ghats of Andhra Pradesh, India. Several range extensions south from the Similipal Hills in Orissa are recorded. The forested area is more important than hitherto thought as a Wintering ground for Palaearctic migrants and in particular as a stopover for passage migrants. Corresponding to seasonality in rainfall, food supplies are at their lowest levels from December to February. This correlates with the annual cycle of resident species, most of which breed from mid-April to June and moult from July to October, and the appearance of some larger insectivores and frugivores to breed in the Summer months. The various strategies adopted by different species to promote overwinter survival, and the possible impact of Palaearctic migrants on resident species are discussed.

Acknowledgements

Thanks to K. S. R. Krishna Raju and my parents for help and encouragement throughout the study; H. J. Harvey, R. B. Payne, J. C. Daniel and S. D. Ripley for assistance with planning and R. J. Pimento for help with fieldwork. The study would have been impossible without all kinds of aid provided by the Andhra Pradesh Forest Department and its officers. I especially thank Sri Venkata Reddy, Conservator, and D. Bhaskara Rao, Forest Range Officer. This work was sponsored by the Bombay Natural History Society and supported by the Leverhulme Trust

Fund, with additional grants from the British Ornithologist's Union and the Smithsonian Institution.

Appendix

The area within ten kilometres of Lammasinghi includes at least three habitat types not encountered in the study area, and several new bird species. The habitat types are: (1) A ten year old reservoir at Thajangi, (2) Open, dry farmland on the plateau, (3) Farmland on the coastal plain. For the sake of completeness species observed *and identified* in these habitats, but never seen on the study area are detailed below.

Little egret. **Egretta garzetta.**
Up to 20 regularly at Thajangi reservoir.

Pied harrier. **Circus pygargus.**
One near Thajangi on January 6th. Pallid harriers, *C. macrourus,* and probably Hen harriers *C. cyaneus* also occur on the plateau.

Wood sandpiper. **Tringa glareola.**
One on March 22nd beside the river near Thajangi. A regular migrant on the plateau.

Painted snipe. **Rostratula benghalensis.**
Two on January 10th 1978 near Thajangi associated with other snipe, *Gallinago* sp. The *Gallinago* snipes are regularly seen at Lammasinghi in January.

Swallow. **Hirundo rustica.**
Several at Thajangi reservoir on April 1st. A large flock at Sileru on April 9th.

Wiretailed swallow **Hirundo smithii.**
2 at Thajangi reservoir on April 1st.

Black drongo. **Dicrurus adsimilis.**
Common on the coastal plain, and seen occasionally on the more open parts of the plateau.

House crow. **Corvus splendens.**
Common on the coastal plain. Never recorded on the plateau.

Whiteheaded babbler. **Turdoides affinis.**
Common on the coastal plain.
Streaked fantail warbler. **Cisticola juncidis.**
One in mid June on the open plateau. Common at higher, wetter elevations (Price, in press).

Paddyfield pipit. **Anthus novaeseelandiae.**
Occasionally seen on drier areas of the plateau.

White wagtail. **Motacilla alba.**
Three at Thajangi on January 11th.

Large pied wagtail. **Motacilla maderaspatensis.**
Two regularly seen at Thajangi reservoir. Display noted at Sileru on April 9th.

Yellowthroated sparrow. **Petronia xanthocollis.**
Seen in bamboo clumps downhill from Lammasinghi on April 30th. Fairly common on the coastal plain.

References

Abdulali, H. (1945): Birds of the Vizagapatnam District. *J. Bombay nat. Hist. Soc. 45*: 333-347.

——— (1949): Some peculiarities of avifaunal distribution in Peninsular India. *Proc. Natl. Inst. Sci. India 15*: 387-393.

——— (1953): More about Vizagapatnam birds. *J. Bombay nat. Hist. Soc. 51*: 746-747.

Ali, S. (1932): Flower Birds and Bird Flowers of India. *J. Bombay nat. Hist. Soc. 35*: 573-605.

Ali, S. (1968-1974): Handbook of the Birds of India and Pakistan. Ten volumes. Oxford University Press.

Champion, H. G. & Seth, S. K. (1968): A revised survey of the Forest types of India. Delhi, Manager of Publications.

Chipley, R. M. (1976): The impact of migrant warblers on resident Passerines in a subtropical Colombian woodland. *The Living Bird 15*: 119-142.

DAVIES, N. B. (1976): Food, flocking and territorial behaviour of the Pied Wagtail (*Motacilla alba yarrelli* Gould) in Winter. *J. Anim. Ecol. 45*: 235-254.

FOGDEN, M. P. L. (1972): The Seasonality and Population dynamics of Equatorial forest birds in Sarawak. *Ibis 144*: 307-343.

GASTON, A. J. (1975): The moult of the Blyth's Reed Warbler, *Acrocephalus dumetorum*, with notes on the moult of other Palaearctic warblers in India. *Ibis 117*: 247-251.

HORA, S. L. (1949): Satpura hypothesis of the distribution of the Malayan fauna and flora to peninsular India. *Proc. Natl. Inst. Sci. India 15*: 309-314.

HUSSAIN, S. A., PANDAY, J. D. & SHEKAR, P. B. (1976): Extension of the range of the Large Yellownaped Woodpecker (*Picus flavinucha flavinucha* Gould). *J. Bombay nat. Hist. Soc. 73*: 394.

JANZEN, D. H. (1973): Sweep samples of tropical foliage insects: effects of seasons, vegetation types, elevation, time of day, and insularity, *Ecology 54*: 687-708.

KARR, J. R. (1971): Structure of Avian communities in selected Panama and Illinois habitats. *Ecol. Monographs 41*: 207-233.

——————— (1976a): Seasonality, Resource Availability, and Community diversity in Tropical bird communities. *Am. Nat. 110*: 973-994.

——————— (1976b): On the relative abundance of migrants from the North Temperate zone in Tropical habitats. *Wilson Bulletin 88*: 433-458.

LACK, D. 1966): Population Studies of Birds. Clarendon Press, Oxford.

MACARTHUR, R. H. & WILSON, E. O. (1967): The Theory of Island Biogeography. Princeton University Press. Princeton, N.J.

MOREAU, R. E. (1972): The Palaearctic-African Bird Migration Systems. Academic Press, London.

NEAVOLL, G. F. (1968): A further note on the distribution of *Cuculus canorus* Linnaeus. *J. Bombay nat. Hist. Soc. 65*: 775-776.

NEWTON (1966): The moult of the Bullfinch, *Pyrrhula pyrrhula. Ibis 108*: 41-67.

NISBET, I. C. T. & LORD MEDWAY (1972): Dispersion, population ecology and migration of Eastern Great Reed Warblers *Acrocephalus orientalis* wintering in Malayasia. *Ibis 114*: 451-494.

PRESTON, F. W. (1962): The canonical distribution of commonness and rarity. *Ecology 43*: 185-215; 410-432.

PRICE, T. D. (in press): Some observations on the warblers of the upland perennial wetlands in the Eastern Ghats. *J. Bombay nat. Hist. Soc. 75* (2): 488-490.

——————— (1978): The ecology of the Greenish, Warbler, *Phylloscopus trochiloides* (Sundevall) in its Winter quarters. MS.

RAJU, K. S. R. KRISHNA & PRICE, T. D. (1973): Tree Sparrow, *Passer montanus* (L.) in the Eastern Ghats. *J. Bombay nat. Hist. Soc. 70*: 557.

——————— & SELVIN, J. P. (1971): Little Spiderhunter, *Arachnothera longirostris* (Latham) in the Eastern Ghats. *J. Bombay nat. Hist. Soc. 68*: 454.

RIPLEY, S. D. (1979): Changes in the bird fauna of a forest area; Simlipal Hills, Mayurbhanj District and Dhenkanal District, Orissa. *J. Bombay nat. Hist. Soc. 75*(3): 570-574.

——————— (1961): A Synopsis of the Birds of India and Pakistan. Bombay Natural History Society.

SNOW, D. W. (1976): The relationship between climate and annual cycles in the Cotingidae. *Ibis 118*: 366-401.

SALOMONSEN, M. G. & BALDA, R. P. (1977): Winter Territoriality of Townshend's Solitaires (*Myadestes townshendi*) in a Pinon-Juniper-Ponderosa Pine ecotone. *The Condor 79*: 148-161.

SOUTHWOOD, T. R. E. (1966): Ecological Methods. Methuen, London.

WHISTLER, H. & KINNEAR, N. B. (1932-1939): The Vernay Scientific Survey of the Eastern Ghats. in 16 parts. See *J. Bombay nat. Hist. Soc. 39*: 447-463.

DISTRIBUTION, STATUS, HABITAT AND FOOD OF THE URIAL (*OVIS ORIENTALIS PUNJABIENSIS*) IN THE PUNJAB[1,2]

Z. B. Mirza,[3] M. Aslam Khan,[4] M. Asghar,[5] and Abdul Qadeer Mehal[6]

(*With three text-figures and a map*)

Punjab Urial occurs in Kala-Chitta and Salt ranges between 32° 25′ & 33° 70′ north latitude and 71° 50′ & 73° 70′ east longitude in the Punjab Province of Pakistan. On the western edges of these ranges flows the Indus river which is the physical barrier between animals which inhabit the hills along both sides of its banks. It is not certain whether the animals on the west bank of Indus river are *Ovis. o. punjabiensis, O.o. cycloceros* or *Ovis o. blanfordi* (Schaller & Mirza 1974). This paper gives census figures, description of habitat and food of *O.o. punjabiensis.*

Census method

Counting was done twice each day. In the morning usually half hour before sunrise and three hours afterwards and later two hours before sunset till dark. At these times the animals were most active. They were more mobile during rut which is in November. The herds were classified as male herds and female herds which consisted of ewes, lambs and yearlings. Mixed herds comprised rams, ewes, yearlings and lambs. These were classified as to age and sex. The age of males were estimated by the comparative length of the horns. In order to avoid double counting sketches of males were drawn showing the front, left and right views. Any visible marks on the bodies including sizes and shapes of the horns were marked on these sketches. The presence of identifiable individuals within a herd and the herd composition helped in the identification of the herds. Males 1½ years old were classified as yearlings, 2½ years as class I, 3½ years class II, 4½ years Class III and full grown as Class IV (Schaller & Mirza 1974). The females were difficult to classify as to their age groups, even sometimes yearling females could not be distinguished from adult females. The advanced stage pregnant ewes could also be distinguished.

Distribution & population

The whole census was undertaken area by area. The census in Jaba (District Mianwali) a private reserve of Maliks of Kalabagh was conducted during April 1976. There were

[1] Accepted January, 1979.

[2] This project was financed partly by a grant from U.S. Department of Agriculture under PL-480 and partly by the Punjab Government.

[3] Administrator WWFP/Principal Investigator, PL-480, Research Project, 37-F, Model Town, Lahore.

[4] Assistant Research Officer, now Research Officer in Forest Department.

[5] Assistant Research Officer.

[6] Assistant Research Officer, now Assistant Game Warden.

1288 animals concentrated on the hills & nullahs in 16 sq. miles area. However, these did spread in a bigger area of lower hills and plateaux in winter or early spring and occupied more or less 20 sq. miles. Total of 966 females, 38 lambs, 19 male yearlings, 5 males Class I, 36 Class II, 30 males Class III and 194 males Class IV were counted (Table 1).

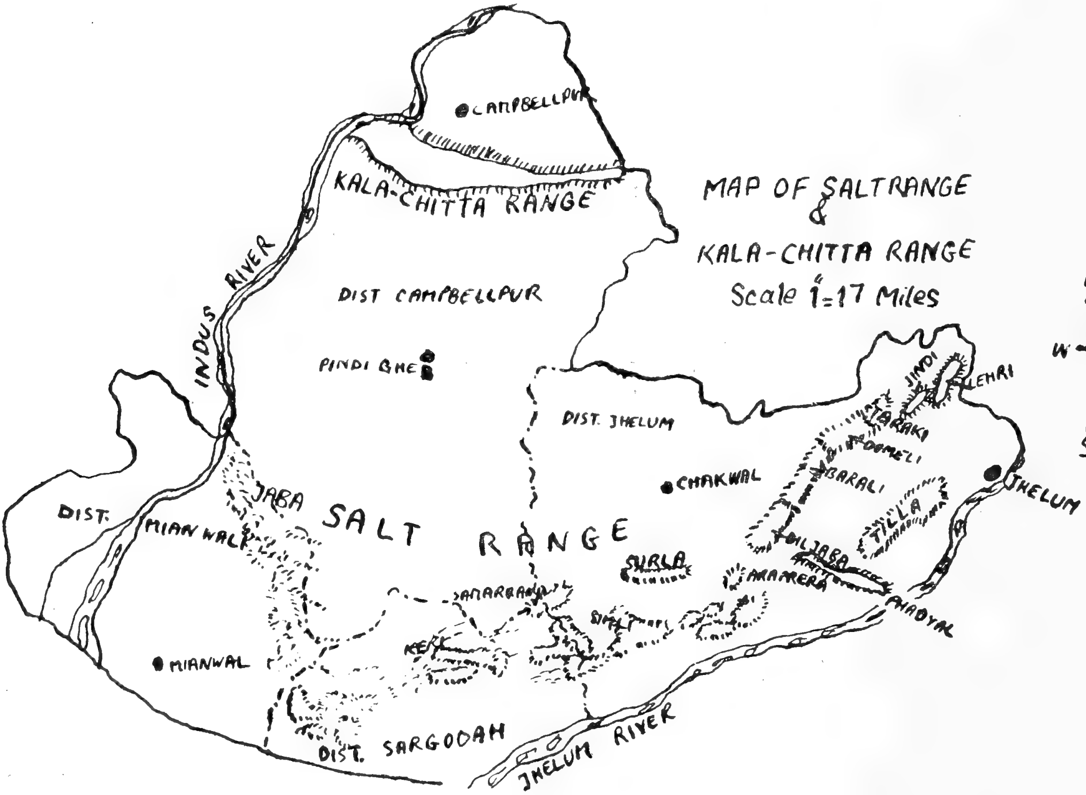
Urials in District Jhelum were counted during March, May and June, 1976. There were 588 animals in roughly 456 sq. miles area. Out of this 284 were females, 105 lambs, 44 male yearlings, 28 males class I, 46 males Class II, 18 males Class III and 63 males Class IV (Table 1).

The census in Salt Range in the District of Sargodha was completed in January, 1977 and 68 animals were sighted in 278 sq. miles area comprising of 33 females, 3 lambs, 2 male yearlings, 7 males Class I, 10 males Class II, 6 males Class III and 7 males Class IV (Table 1).

During November and December, 1976 census of Kala Chitta range (District Campbellpur) was carried out. A total of 213 animals were observed. There were 81 females, 12 lambs, 14 male yearlings, 12 males Class I, 13 males Class II, 21 males Class III, and 36 males Class IV.

Habitat

The general orientation of the Salt Range and Kala Chitta Range is east-west (see map).



Map of Salt Range and Kala-Chitta Range.

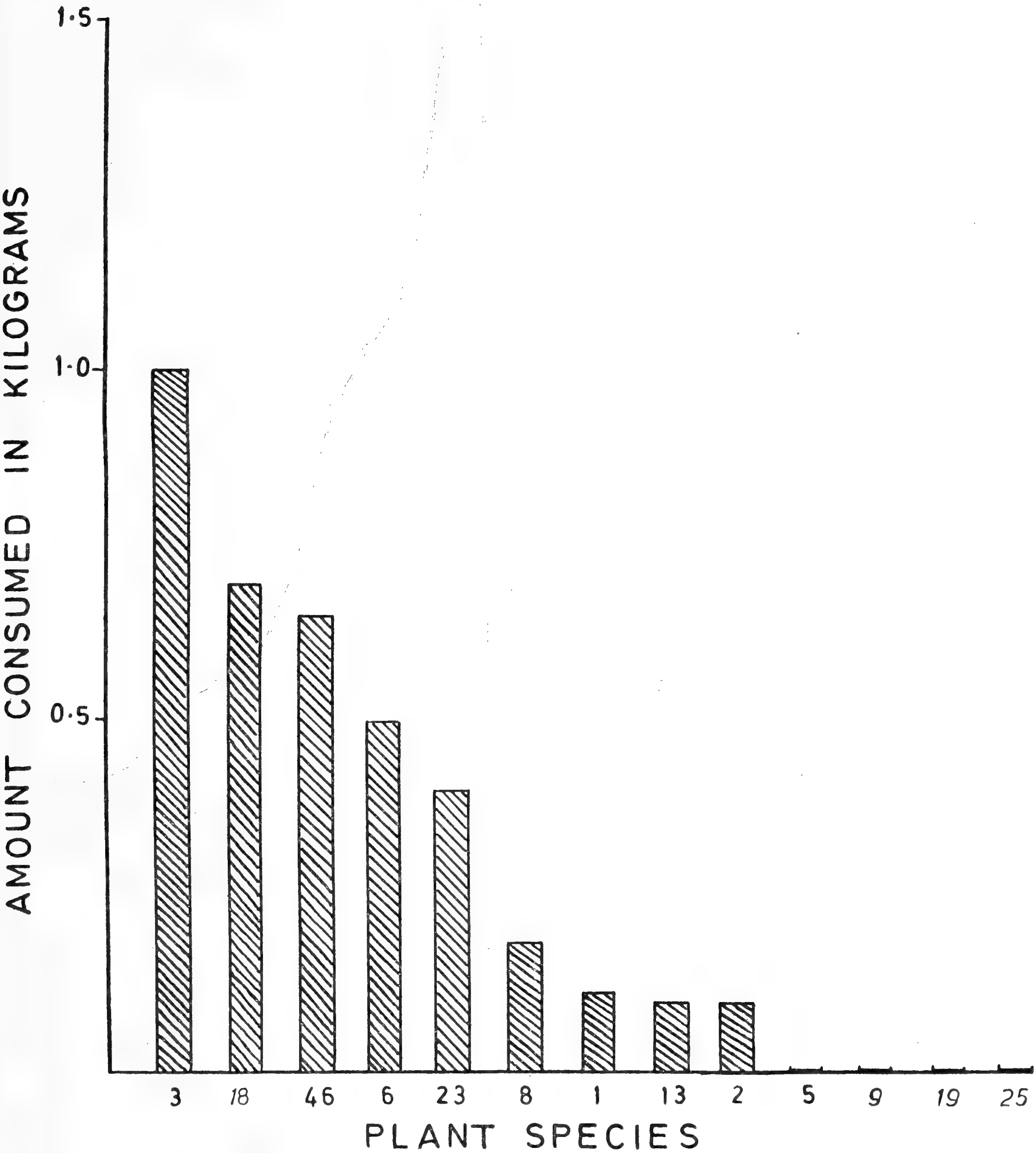


Fig. 1. Amount consumed of each plant species by Urial. The numbers refer to the names indicated in the Table 2.

Each of the component hills is made up of a number of parallel ridges. But this parallelism is modified by a marked tendency to a linked or loop formation. The main ridges bend in towards one another and mingle in a knotted mass (Rana 1956). The vegetation of the Salt and Kala Chitta ranges is dry deciduous scrub forest mainly *Olea cuspidata* and *Acacia* sp., found on hilly ground and on shallow dry soil over marl, limestone and sedimentary rocks and sandstones from 457 to 1524 metres. The maximum average summer temperature is 45.55°C (114°F) and minimum average winter temperature is –6.11°C (21°F). The annual rainfall which is mainly in summer is from 51 cm (20″) to 102 cm (40″) (Ripley 1961) Water runs off the slopes after every downpour eroding the soil and swelling the streams. Most of top soil of the area has already been washed away. Erosion has reached an advanced stage in some parts and bare infertile rocks have been exposed which can support no vegetation. The plant cover is poor on sandstone and red marl. The average annual rainfall decreases from east to west causing marked scarcity of vegetation in the west as compared to that on the east. The density of vegetation on southern aspects is poor while the northern slopes are comparatively better. *Olea cuspidata, Acacia modesta, Dodonea viscosa* and *Cymbopogon jawarancusa* are prominent.

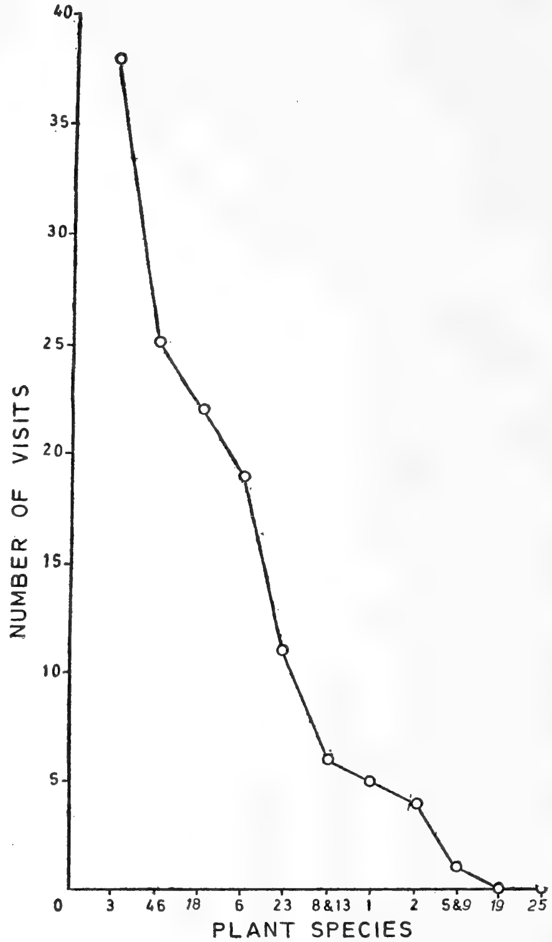


Fig. 2. Number of visits for each plant species. The numbers refer to the names indicated in Table 2.

The percentage of plant ground and canopy cover was estimated in Salt range in districts of Jhelum, Sargodha and Mianwali and Kala Chitta range in District Campbellpur, by 345 random sample plots of 0.01 acre roughly 100 metres apart (Table 2). Average plant cover was estimated to be 43.5% in Salt Range in summer and winter and 45.2% in Kala Chitta range in winter.

The comparative abundance of each plant species was also determined by laying random plots on the flats, nullahs, steep and gentle slopes, counting each and every plant of different species within the plot. The dominant plant species in Salt and Kala Chitta ranges were found to be *Acacia modesta, Zizyphus nummularia, Olea cuspidata, Dodonaea viscosa* and grasses like *Cymbopogon jawarancusa, Eleusine compressa, Heteropogon contortus, Aristida adscensionis, Bothriochloa pertusa,*

TABLE 1

CENSUS OF URIAL (*Ovis orientalis punjabiensis*) IN SALT AND KALA CHITTA RANGES

Locality	Month	Female Adults	Lambs	Male yearlings	Males Class I	Males Class II	Males Class III	Males Class IV	Total
Jaba Sanctuary, District Mianwali.	April, 1976	966	38	19	5	36	30	194	1288
District Jhelum.	March, May and June, 1976	284	105	44	28	46	18	63	588
District Sargodha.	January, 1977	33	3	2	7	10	6	7	68
Kala Chitta Range, District Campbellpur.	November and December, 1976	81	12	14	12	13	21	36	189
									2133
Additional animals which could not be classified according to their age group.									24
								Total	2157

TABLE 2

PERCENTAGE OF OCCURRENCE OF PLANT SPECIES

No.	Plant Species	SARGODHA Average of 50 Samples	JHELUM *Salt Range* Average of 120 Samples	CAMPBELLPUR *Kala-Chitta Range* Average of 75 Samples	MIANWALI *Jaba Reserve* Average of 100 Samples
1.	Pharian (*Digitaria bicornis*)	Nil	2.91	Nil	1.25
2.	Chhimber (*Eleusine compressa*)	2.05	10.08	2.61	17.20
3.	Phulai (*Acacia modesta*)	7.05	10.87	12.19	3.90
4.	Bhabbar (*Eulaliopsis binata*)	Nil	8.83	Nil	3.90
5.	Lumb (*Aristida adscencionis*)	Nil	5.83	1.39	4.70
6.	Sand (*Lasirus hirsutus*)	5.06	1.91	4.49	3.00
7.	Kau (*Olea cuspidata*)	8.40	5.54	16.00	Nil
8.	Dhaman (*Cenchrus ciliaris*)	tr.	1.04	0.29	6.10
9.	Khar (*Chrysopogon montanus*)	7.00	12.50	10.78	6.70
10.	Karir (*Capparis aphylla*)	1.90	1.12	1.00	0.90
11.	Palwan (*Bothriochloa pertusa*)	2.50	3.21	2.09	0.95
12.	Pataki (*Gymnosporia royleana*)	Nil	3.04	Nil	0.25
13.	Khawi (*Cymbopogon jawarancusa*)	10.50	4.29	15.70	17.70
14.	Bahekar (*Adhatoda vasica*)	4.10	2.25	2.10	0.10
15.	Sanatha (*Dodonaea viscosa*)	11.45	6.25	13.28	1.20
16.	Unidentified species	0.65	1.70	0.15	2.30
17.	Khatti Booti (*Oxalis corniculata*)	Nil	tr.	Nil	tr.
18.	Malla (*Zizyphus nummularia*)	3.70	3.25	6.30	1.35
19.	Sariala (*Heteropogon contortus*)	4.25	5.28	4.27	0.85
20.	Bata (*Periploca aphylia*)	Nil	0.92	Nil	0.20

No.	Plant Species	SARGODHA	JHELUM	CAMPBELLPUR	MIANWALI
21.	Maina (*Medicago lupulina*)	0.49	0.75	tr.	3.15
22.	Dab (*Desmostachya bipinnata*)	Nil	0.71	Nil	1.30
23.	Khabble (*Cynodon dactylon*)	6.25	0.67	5.80	3.95
24.	Wan, Jaal (*Salvadora oleoides*)	Nil	0.58	Nil	0.95
25.	Bui (*Aerva javanica*)	1.00	0.42	0.75	0.45
26.	Kahi (*Saccharum spontaneum*)	Nil	0.40	Nil	1.80
27.	Kandiari (*Echinops echinatus*)	Nil	0.37	Nil	tr.
28.	Kana (*Saccharum munja*)	0.81	0.33	1.58	1.60
29.	Sakkar (*Eheretia aspera*)	Nil	0.33	Nil	0.10
30.	Dodak (*Sonchus asper*)	Nil	0.25	Nil	tr.
31.	Giddar Tambakoo (*Verbascum thapsus*)	Nil	0.17	Nil	Nil
32.	Kikar (*Acacia arabica*)	1.25	0.17	2.30	tr.
33.	Dhania Booti (*Psammogeton biternatum*)	Nil	tr.	Nil	tr.
34.	Khui (*Sporobolus pallidus*)	Nil	tr.	Nil	0.15
35.	Bathu (*Chenopodium album*)	0.52	tr.	tr.	tr.
36.	Bhakhra (*Tribulus alatus*)	Nil	tr.	Nil	tr.
37.	Harmal (*Peganum harmala*)	0.72	tr.	0.37	tr.
38.	Waliati Kikar (*Acacia farnesiana*)	Nil	tr.	Nil	0.15
39.	Vina (*Rhazya stricta*)	Nil	tr.	Nil	2.00
40.	Ak (*Calotropis procera*)	0.67	tr.	0.50	tr.
41.	Mako (*Solanum nigrum*)	0.35	tr.	0.10	tr.
42.	Ispghol (*Plantago ciliata*)	Nil	tr.	Nil	1.00
43.	Pohli (*Solanum xanthocarpum*)	0.26	tr.	tr.	0.15
44.	Kandiara (*Cousinia minuta*)	Nil	tr.	Nil	0.06
45.	Sonchal (*Malva parviflora*)	0.20	tr.	tr.	tr.
46.	Ganger (*Grewia populifolia*)	3.29	1.58	5.76	0.80
47.	Dhamian (*Fagonia cretica*)	Nil	tr.	Nil	0.50
48.	Deela (*Cyperus pilosus*)	Nil	tr.	Nil	0.40
49.	Gam (*Panicum antidotale*)	0.05	tr.	tr.	0.15
50.	Jandi (*Prosopis spicigera*)	1.12	tr.	2.68	0.20
51.	Farwan (*Tamarix* sp.)	Nil	tr.	Nil	1.40
52.	Kaner (*Nerium odorum*)	1.60	tr.	0.89	0.80
53.	Shisham (*Dalbergia sissoo*)	0.90	tr.	0.52	0.20
54.	Khajour (*Phoenix* sp.)	0.15	—	0.32	0.10
55	Dab (*Typha latifolia*)	1.40	—	2.17	0.20
56.	Equisetum (*Equisetum* sp.)	Nil	—	Nil	0.10
57.	Chag (*Crotalaria burhia*)	1.78	Nil	1.20	Nil
58.	Ber (*Zizyphus jujuba*)	1.52	Nil	1.13	Nil
59.	Mesquit (*Prosopis glandulosa*)	0.95	Nil	0.60	Nil
60.	Toot (*Morus alba*)	0.85	Nil	Nil	Nil
61.	Aksin (*Withania somnifera*)	0.76	Nil	0.41	Nil
62.	Dhrek (*Melia azedarach*)	0.60	Nil	Nil	Nil
63.	Jawan (*Alhagi maurorum*)	0.40	Nil	0.28	Nil
64.	Nara (*Arundo donax*)	0.11	Nil	0.21	Nil
65.	Pilchhi (*Tamarix dioica*)	Nil	Nil	1.60	Nil
66.	Pipal (*Ficus religiosa*)	Nil	Nil	0.92	Nil
67.	Burh (*Ficus bengalensis*)	Nil	Nil	0.76	Nil
68.	Mesquit (*Prosopis juliflora*)	Nil	Nil	0.29	Nil

tr. = trace.

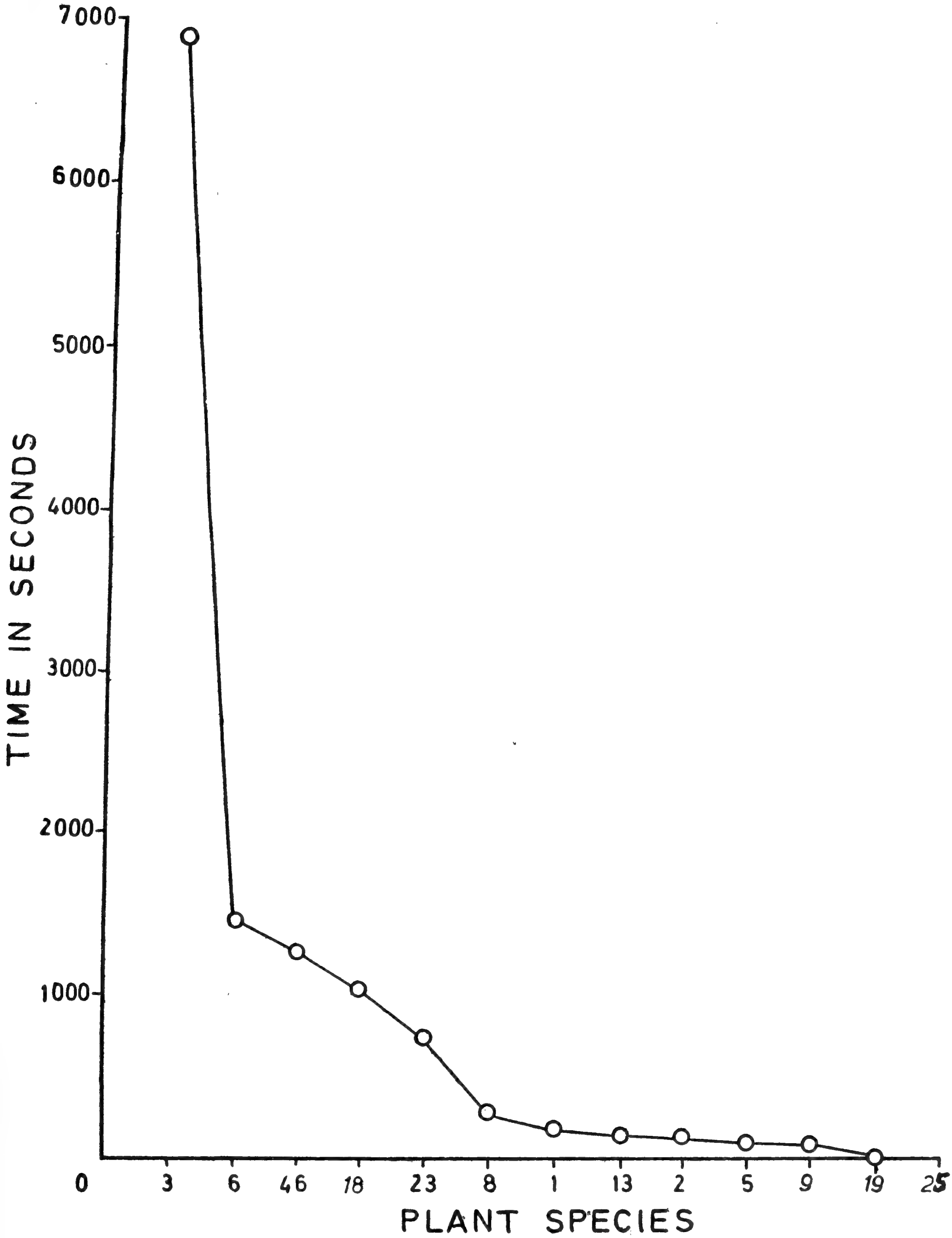


Fig. 3. Time spent in seconds for each plant species. The numbers refer to the names indicated in the Table 2.

Digitaria bicornis, Eulaiopsis binata, Cynodon dactylon, Saccharum sp., *Sporobolus pallidus, Cenchrus ciliaris* and *Chrysopogon montanus* etc.

Food Plants

Plants palatable to Urial were determined by the method described by Mirza (1973) as well as by visual observations. Two captive urial (one male and one female) were given no food for 12 hours prior to feeding. Then 2 Kilograms piles of each plant species were placed in a row inside the enclosure. Number of visits made to each pile, time spent and the amount consumed were noted (Figs. 1, 2 & 3). *Acacia modesta,* was observed to be the favourite browse. Next in order of preference were *Zizyphus nummularia,* and *Grewia populifolia.* Among the grazeable vegetation *Lasiurus hirsutus* was the favourite grass. Next in order of preference were *Cynodon dactylon, Cenchrus ciliaris, Digitaria bicornis, Cymbopogon jawarancusa, Eleusine compressa, Aristida adscencionis* and *Chrysopogon montanus.*

General observations

Poaching, particularly collection of lambs over the entire Salt and Kala Chitta ranges is the primary factor for the markedly reduced population. This is obvious when the status of population is compared to that of Jaba Reserve which is roughly 16 sq. miles and holds almost half of the total population of Punjab Urial. Due to severe pressure on food wild plants by domestic livestock the vegetation has become over-grazed or over browsed. Urials confine themselves to comparatively difficult terrain where competition is less or they browse and graze before and after the domestic animals are brought for grazing. In areas where forage conditions are poor and reduced in winter and in drought season and where cultivations are near the hills the Urial move for forage under the cover of darkness.

In Jaba, because of the abundance of food and very little food competition with domestic livestock throughout the year, twin births are frequent which rarely happens in any other area outside this reserve. This was seen by us during our visits. Jaba reserve has quite a few domestic goats, sheep and cattle but these are not allowed to graze in the general area which is inhabited by Urials.

Acknowledgements

Thanks are due to Dr. Jack Ward Thomas, United States Department of Agriculture, Forest Service and Dr. G. B. Schaller, New York Zoological Society for critically reviewing the manuscript. Thanks are also due to Dr. Sultan Ahmed Chaudhry, Rtd. Professor of Botany, Government College, Lahore, for identifying plants. We are particularly indebted to Maliks of Kalabagh for the facilities provided by them in their Sanctuary at Jaba.

References

Mirza, Z. B. (1973): Food availability for Blackbuck (*Antilope cervicapra*) at Lal Suhanra Sanctuary, Pakistan. *Biological Conservation* 5(2).

Rana, Said Muhammad, (1956): The Working Plan for the Forests of Jhelum, Mianwali and Shahpur Forests Divisions, Punjab Government Printing Press, Lahore.

Ripley, Sidney Dillon (1961): A Synopsis of the Birds of India and Pakistan, Bombay Natural History Society.

Schaller, G., and Mirza, Z. (1974): On the behaviour of Punjab Urial (*Ovis orientalis punjabiensis*). The Behaviour of ungulates and its relation to Management Vol. (1) IUCN, Morges, Switzerland. 306-12.

OBSERVATIONS ON THE BREEDING OF MAJOR CARPS IN A DRY BUNDH OF UTTAR PRADESH DURING 1976 MONSOON SEASON[1]

S. J. Karamchandani, G. N. Mukerji, G. N. Srivastava and K. Chandra[2]

(*With a text-figure*)

Introduction

For production of fish seed, bundh breeding has been a popular method in Bengal and Madhya Pradesh for the last several years. While in West Bengal it is practised by private fish farmers, most of the dry bundhs of Madhya Pradesh are managed and operated by the State Fisheries Department. Breeding of major carps is carried out in dry bundhs on a large scale in the Bankura and Midnapore districts of West Bengal, giving no particular attention to details relating to the number of breeders per unit area of a bundh, the ratio of male and female breeders, size compatibility or the condition of their gonads (Dubey 1969). In these bundhs, the breeding of major carps is induced by artificially flooding them and thereby creating fluviatile conditions. However, in the Bankura district a few of the brood fishes are invariably administered pituitary hormone injections, taking no cognizance of the ratio between the numbers of injected and uninjected fishes to generate sympathetic breeding response among the rest of them. The bundh breeding technique adopted in Sonar Tallaiya (Dist. Chhatarpur) in Madhya Pradesh in the year 1958, however, makes a departure from the usual practice in that it makes no provision for outflow of water at the time of breeding (Dubey and Tuli 1961 and Dubey *et al.* 1968).

In the present communication are given the results of experiments on the bundh breeding of major carps which were conducted at the Ganne dry bundh of Uttar Pradesh near Allahabad during the 1976 monsoon season.

Description of Ganne dry bundh:

Ganne dry bundh is located at a distance of 45 km from Allahabad near Ganne village in Tahsil Karchna of Allahabad district (25°N, 81°71′E) on Allahabad-Rewa Road (Fig. 1).

It was constructed by the U.P. Fisheries Department in the year 1971 by putting an earthen dam wall, across the 'run-off' from the catchment area, with masonry structure of waste weir and sluice gate in the centre of the dam wall. The waste weir is provided with a set of screens made of expanded metal, along its entire length to permit over-flow of water and prevent the escape of breeders from the bundh whereas provision is made to guard the sluice gate by two types of screens, one made of expanded metal for preventing the escape of breeders, when the sluice gate is opened to maintain the water current within the bundh and the other fine meshed one which is fitted after breeding for preventing the loss of fertilized eggs.

[1] Accepted May 1978.

[2]Central Inland Fisheries Research Sub-station, 24 Pannalal Road, Allahabad (U.P.)

The bed of the bundh is studded with boulders at several places. The bundh has a gradually sloping catchment area of 1.6 square km which is mostly rocky and with laterite soil. The entire catchment area is covered with *Dhak* plants and small bushes. A small rivulet provides an inlet to the bundh on its western side. The water from waste-weir and sluice gate flows through an outlet into a nalah on the eastern side of the bundh.

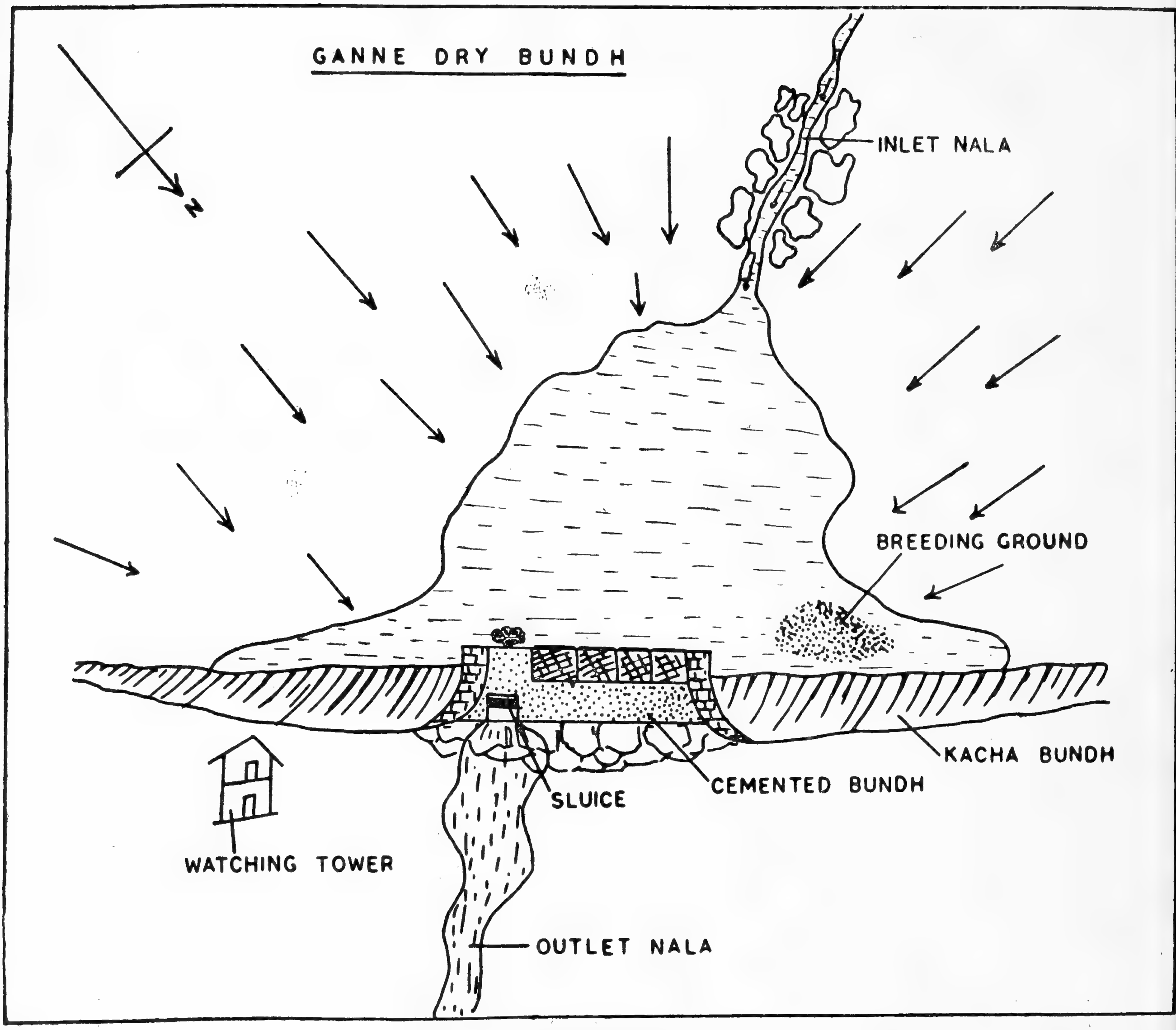


Fig. 1. Sketch of Ganne dry bundh.

Material and methods

For conducting breeding experiments in Ganne dry bundh, in all 39 breeders of *Labeo rohita* (Ham.) and *Cirrhinus mrigala* (Ham.) with ripe gonads in prime condition were procured from the Tendua Fish Farm of Uttar Pradesh Fisheries Department and transported in Plastic Pools fitted in a Jeep Trailer, covering a distance of 85 km. When sufficient rain water draining about one square mile of catchment area was impounded in the dry bundh, 18 breeders of *Labeo rohita* and 21 of *Cirrhinus mrigala* were introduced in two batches on 3rd and 12th August 1976. The breeders which were experimented with had the following length and weight ranges, and sex ratio (Table 1).

Table 1

Species	Length range (mm)	Weight range (gm)	Sex ratio (by number)
L. rohita	235-420	150-700	1 M : 1 F
C. mrigala	240-440	200-1200	2 M : 1 F

Prior to introducing the breeders into the bundh, male and female were kept segregated in Tendua Fish Farm, as has been recommended by several fishery scientists. In the absence of stocking ponds at bundh site, different sex ratios could not be attempted nor was it possible to attempt successive breeding experiments.

Proper screening of breeders in respect of state of gonads was done before introducing them into the bundh. The males were selected initially on the basis of roughness of pectoral fins and operculum and oozing of milt on slight pressure on the abdomen. For the selection of ripe gravid females, the characters like bulging, soft abdomen and swollen vent were taken into consideration. The extrusion of eggs with slight pressure on abdomen was taken as sure test for ripeness of the ovary.

The initial objective of experiments on bundh breeding was to elucidate meteorological, physico-chemical, and biological factors specific to breeding. With failure of breeders of first batch introduced in the bundh on 3rd August 1976 to respond to breeding due to drought conditions prevailing until 11th August 1976, one set (2M:1F) each of rohu and mrigal, out of second lot of breeders, was administered with pituitary hormone injection and released along with remaining uninjected breeders in the bundh on 12th August 1976 with a view to evoking sympathetic breeding and determining the optimum ratio between injected and uninjected breeders.

With the conclusion of experiments, the breeders were netted out from the bundh and were examined externally to ascertain the number of breeders that had bred.

During the entire period of investigations, observations with regard to meteorological and physico-chemical conditions and fluctuations on water level in the bundh were made.

Observations and results

After the accumulation of rain water in the bundh resulting from initial rains in the last week of June and subsequent erratic rains in the following month, the first batch of breeders was released on 3rd August 1976. While negligible rains were experienced during the entire month of July and early part of the following month, a heavy downpour was recorded in the night between 11th and 12th August 1976, thereby raising the water level consider-

ably within the bundh. The downpour and the resultant influx of water into the bundh hardly evoked any breeding among the breeders stocked on 3rd August 1976 and moreover the number of breeders in the bundh had dwindled as a result of periodical mortality between 3rd and 11th August 1976 evidently due to rise in water temperature in the bundh. Due to this exigency, the second batch of breeders was procured in the late afternoon of 12th August 1976. Since the normal breeding conditions did not prevail and the resorption of the gonads was feared, one set (2M:1F) each of rohu and mrigal, out of the second batch, was given pituitary hormone injection prior to their being released into the bundh along with other breeders of the lot in order to facilitate sympathetic breeding among the remaining uninjected breeders. After a few hours of releasing the second lot of breeders including a sub-set of injected ones, a heavy downpour was experienced and a congregation of fish was noticed in the evening on the north-west bank of the bundh, about 50 feet from the waste weir. Within the following few hours, the accumulated rain water covered a large peripheral area of the bundh, raising the water level within the bundh considerably. At this stage, the sluice gate was fully opened to permit outflow of excess water. This was mainly done for two reasons—firstly, to maintain water current within the bundh as this factor is said to be conducive for breeding and secondly, to obviate breach in the earthen bundh as it was feared that accumulated water within the bundh may exert pressure on the bundh resulting in breach of bundh as was observed to happen during 1975 monsoon season. The breeders were seen moving about actively in the shallow regions where the water depth was less than one metre. A constant vigil was kept from the observation tower throughout the night, when sex play was observed to be in progress, and the breeding took place sometime in the early hours of 13th August 1976 and also on 14th August 1976 near the north-west bank of the bundh where a mild water current was observed. A fairly strong water current main-

TABLE 2

PHYSICO-CHEMICAL CONDITIONS OF BUNDH WATER RELATING TO PRE-, DURING AND POST BREEDING PERIODS

Physico-Chemical Factors	Pre-Breeding period	Breeding Period	Post-Breeding Period
Air Temperature °C	26.0 — 31.0	26.8	27.0 — 30.0
Water Temperature °C	26.8 — 31.8	27.4 — 28.0	28.0 — 31.0
Dissolved Oxygen (ppm) d.o.	6.2 — 8.2	5.6 — 7.6	6.0 — 7.0
Free CO_2 (ppm)	1.0 — 4.0	2.0 — 12.0	1.0 — 6.0
pH	7.8 — 8.0	7.6	7.6 — 8.0
Hardness (ppm)	18.0 — 22.0	16.0 — 22.0	18.0 — 20.0
Total Alkalinity as $CaCO_3$ (ppm)	36.0 — 50.0	28.0 — 32.0	30.0 — 34.0
Calcium (ppm)	24.0 — 36.0	24.0	22.0 — 24.0
Silicate (ppm)	8.0 — 10.0	8.0	8.0
Phosphate (ppm)	0.01	0.01	0.01
Organic Carbon (ppm)	8.8 — 10.2	6.8 — 8.0	5.8 — 7.0
Transparency (cm)	10.6 — 21.0	10.6 — 12.0	8.0 — 12.0

tained by outgoing water was, however, observed near the waste weir and fertilized eggs in lakhs were seen being washed away from the spawning ground and escaping through sluice gate along with gushing waters. The attempt at collecting the fertilised eggs with a piece of mosquito netting cloth by filtering gushing water at the other side of the sluice gate was not successful as majority of them got ruptured in the process of collection in this manner. The fertilised eggs at the spawning ground were allowed to remain undisturbed for about 8 hours, in order to obviate the rupture of egg shells and consequent damage of developing embryos. The eggs subsequently collected from the spawning ground were hatched in double walled hatching *hapas* fixed in the bundh itself. The hatchlings on rearing were found to be mostly of mrigal (70%) and few of them belonged to rohu (30%).

On the breeding day, the air and water temperature were 26.8°C and 27.7°C respectively, pH (7.6), D.O (5.6-7.6 ppm) and total alkalinity (28-32 ppm) was relatively low, while value of free CO_2 was high (12.0 ppm). The high values of free CO_2 reflects the absence of carbonate content of water. The details of physico-chemical features relating to pre-, during and post breeding periods are shown in Table 2.

Discussion

The year 1976 was marked by erratic monsoons, and drought conditions prevailed until 11th August. Though the first batch of breeders with ripe gonads in prime condition was stocked in Ganne dry bundh on 3rd August after the accumulation of sufficient water in it the breeding among them was not induced upto 11th August due to lack of heavy flooding of the bundh and other associated conditions. Khan (1924) and Ganapati and Chacko (1954) observed that flooding in the early phase of south-west monsoons is necessary and the fish do not spawn if the rains are delayed. Khanna (1958) reported that during the course of his observations the fish did not breed during the years when the floods were insufficient and untimely. Bhimachar and Tripathi (1967) stated that the breeding among major carps is induced by suitable meteorological conditions during monsoon period. Further they stated that the breeding season of major carps is short and the optimum weather conditions are limited to a few days during this (monsoon) period and as such the scope of induced breeding is very much restricted, even when a good stock of breeders is available.

The heavy monsoon showers in the catchment area of Ganne dry bundh resulting in heavy flooding of the bundh was experienced in the night of 11th/12th August, which amply provided favourable conditions for the breeding of major carps in the bundh. Since the resorption of the gonads of major carps is generally believed to commence by mid August, it was considered that the breeders were not in a condition to respond to suitable environmental conditions prevailing then, fearing that their gonads were already on way to resorption. Therefore amongst the second batch of breeders which were obtained on 12th August 1976 for stocking the dry bundh, one set each of rohu and mrigal (2M : 1F) were administered pituitary hormone injection in order to induce sympathetic breeding among the rest including the breeders stocked on 3rd August 1976. It is significant to record that the breeding in 18 sets of uninjected breeders was stimulated by one set of injected breeders of the two species of fish, ratio between injected and uninjected breeders being 1:9. It would lead to valuable information if further

such experiments are conducted to determine the extent to which optimum ratio between the two could be increased, as this would help saving pituitary gland injection when sympathetic breeding may have to be resorted to on occasions when breeding in dry bundhs does not normally come off due to drought conditions which may happen during monsoons.

Ranganathan *et al.* (1967) reported for the first time successful sympathetic spawning of major carps in cement cistern. Choudary (1968) reported on the indirect inducement of fish breeding in barren bundh-type fishery by selective induced breeding. Mitra (1974) has given observations of an experiment conducted for the purpose of inducing breeding of uninjected breeders kept together with pituitary injected ones in the same confinement. In these instances of sympathetic breeding in cisterns or other confined waters, no account of environmental conditions including physico-chemical factors has been given. While discussing the factors responsible for the breeding of major carps in rivers, reservoirs, ponds etc., Hora (1945), Hussain (1945), Khan (1945), Mookerjee (1945), Chaudhuri (1969) and Ray *et al.* (1969) have considered fresh rain water, flood water, water current, shallow inundated areas and physico-chemical conditions of water, such as turbidity, temperature, pH, dissolved oxygen content, hardness, carbonates, bicarbonates, chlorides etc. as important ecological inducements for natural spawning of Indian major carps. Of these, fresh rain water and flooded condition appear to provide primary stimuli to spawning and sex play, finally resulting in spawning (Singh 1969).

During investigations at Ganne dry bundh, rohu and mrigal breeders were released on 3rd August 76 in the bundh containing rain water accumulated during earlier showers in June, but they did not breed evidently because there were no heavy showers during the period between 3rd and 11th August, 1976 to cause further accumulation of rain water creating flooded conditions within the bundh and also lowering of atmosphere and water temperature—so essential for providing stimulus for breeding (Dubey *et al.* 1968, Chaudhuri 1969, Gupta 1908, Mookerjee *et al.* 1944, Hora 1945, Ganapati *et al.* 1947, Bhimachar & Tripathi 1967 and Selvaraj *et al.* 1971). However, heavy showers in the vicinity of the bundh and resultant on-rush of water in the bundh were experienced on the night of 11th/12th August, 1976, and following two days. With the introduction of one set each of injected rohu and mrigal breeders (2♂:1♀) in the evening of 12th August, 1976 in the bundh, the breeding in the uninjected breeders was induced successfully in the early hours of 13th and 14th August, 1976. This was primarily attributed to heavy showers adding rain water in sufficient quantity in the bundh creating flood-like conditions, and providing moderate water at the spawning ground (De 1910, Khan 1924, Hora 1945, Kussain 1945, Khanna 1958, and Anand 1973). The other factors which were probably conducive to sympathetic breeding in the present case appear to be lower pH (Ganapati and Chacko 1954, Khanna 1958 and Selvaraj *et al.* 1971), lower oxygen content of water (Khan 1924, Alikunhi 1951 and Khanna 1958), lower values of total alkalinity (Saha *et al.* 1957 and Selvaraj *et al.* 1971) and high free carbon dioxide (Selvaraj *et al.* 1971).

ACKNOWLEDGEMENTS

We are grateful to Dr. V. G. Jhingran, Director, Central Inland Fisheries Research

Institute, for his interest in the work, and to Dr. A. V. Natarajan, Head of the Riverine and Lacustrine Division of the Institute, for critically going through the manuscript.

References

ALIKUNHI, K. H. (1951): On an interesting case of carp spawning in the River Cauvery at Bhavani during June, 1947. *J. Bombay nat. Hist. Soc., 50*: 140-46.

———— *et al.* (1964): Observations on the breeding of carps in bundhs near Nowgong, Madhya Pradesh, during July-August, 1964. *Bull. Centr. Inst. Fish. Educ.*, Bombay (1): 22 p.

ANAND, J. N. (1973): Experiments on induced breeding of Indian major carps by pituitary hormone injections in Uttar Pradesh. *J. Inland Fish. Soc., V*, pp. 37-45, Dec. 1973.

BHIMACHAR, B. S. AND TRIPATHI, S. D. (1967): A review of culture fisheries activities in India. F.A.O. Fish. Rep. (44), II: 1-33.

CHAUDHURI, H. (1969): Methods adopted for inducing breeding of fishes. F.A.O./UNDP Regional Seminar on Induced breeding of cultivated fishes, Calcutta, Cuttack, Bombay. FRI/IBCF/4, July 15 to Aug. 18, 1969: p. 16.

CHOUDARY, N. K. (1968): Seminar on Production of quality Fish seed for fish culture. Abstract of papers, ICAR No. 1 & 2, 1968.

DE, K. C. (1910): Report on the Fisheries of Eastern Bengal and Assam, Shillong.

DUBEY, G. P. (1969): Induced breeding of Indian Carp in dry bundhs. FAO/UNDP Regional Seminar on Induced breeding of cultivated fishes, Calcutta, Cuttack, Bombay. FRI/IBCF/21, July 15 to Aug. 18, 1969, 10 P.

DUBEY, G. P., ARJUN SINGH AND PANDEY, M. R. (1968): Fish seed production from Dry-bundhs and its economics. Seminar on production of quality fish seed for fish culture. Barrackpore, November 1 & 2, 1968.

DUBEY, G. P. AND TULI, R. P. (1961): Observations on the breeding of major carps in Madhya Pradesh. *J. Bombay nat. Hist. Soc., 58* (1): 81-91.

GANAPATI, S. V. AND CHACKO, P. I. (1954): Some observations on the spawning of Indian carps in the "bundhs" of Bengal. *Indian Geogr. J.*, 27 (3 & 4): 1-17.

GANAPATI, S. V. *et al.* (1947): Notes on the hydrobiology of carp spawning in the Cauvery. Proc. 34th Indian Sci. Cong., 3, pp. 182-183.

GHOSH, A. C. AND GHOSH, S. N. (1922): Notes on carp breeding and culture in confined waters of Bengal and Bihar. *Bull. Dept. Fish. Bengal, 18*: 1-9.

GUPTA, K. G. (1908): Report on the results of enquiry into the fisheries of Bengal and into fishery matters in Europe and America. Calcutta, 112 p.

HORA, S. L. (1945): Symposium on the factors influencing the spawning of Indian carps. *Proc. natn. Inst. Sci. India* (B), *11*: 303-12.

HUSSAIN, A. (1945): Analysis of experimental data on the spawning of carp in the Punjab. *Proc. natn. Inst. Sci. India* (B), *11*(3) 320-4.

KHAN, H. (1924): Observations on the breeding habits of some fresh-water fishes in the Punjab. *J. Bombay nat. Hist. Soc., 29*(4): 958-62.

———— (1945): Observations on the spawning behaviour of carp in the Punjab. *Proc. natn. Inst. Sci. India, 11*(3): 315-20.

KHANNA, D. V. (1958): Observations on the spawning of the major carps at a fish farm in the Punjab. *Indian J. Fish. 5*(2): 282-90.

MITRA, S. D. (1974): A note on successful sympathetic breeding on Indian Major carps without injecting fish pituitary. *J. Zool. Soc. India* 26, No. 1 & 2: 154-155.

MOOKERJEE, H. K., MAZUMDAR, S. R. AND DAS GUPTA, B. M. (1944): Observations on the breeding grounds and spawning habits of certain Indian carps in the Midnapore district, Bengal with suggestions for their breeding, collection of eggs and rearing of fry. *J. Dept. Sci. Calcutta Univ., 1*(4): 81-91.

MOOKERJEE, H. K. (1945): Factors influencing the spawning of principal carps of India. *Proc. natn. Inst. Sci. India, 11*: 312-15.

RAY, P., KARAMCHANDANI, S. J. AND CHAKRABORTY, R. D. (1969): A note on the breeding of *Labeo gonius* (Ham.) at Jhansi (U.P.) in 1954. *J. Bombay nat. Hist. Soc. 66*(2): 392-394.

RANGANATHAN, V., SREENIVASAN, A., UMMER. K. AND VASUDEVAN, N. K. (1967): Two interesting

cases of spawning of major carps in confined cement tanks. *Curr. Sci. 36*(5): 129-131.

SAHA, K. C., SEN, D. P., ROY CHOWDHARY, A. K. AND CHAKRAVARTY, S. K. (1957): Studies on the factors influencing spawning of Indian major carps in 'Bundh' fisheries. *Indian J. Fish. 4*(2): 284-94.

SELVARAJ, C., RADHAKRISHNAN, S. AND CHATTERJEE, D. K. (1971): Natural spawning of *Labeo boggut* (Sykes) in some drainage channels in Panna, Madhya Pradesh. *J. Inland Fish. Soc. India,* III: 129-30.

SINGH, S. B. (1969): 'Ecological requirements for induced breeding of fishes'. FAO/UNDP Regional Seminar on Induced Breeding of Cultivated Fishes, Calcutta, Cuttack, Bombay, FRI/IBCF/10 P. 1-25.

THE BEHAVIOUR OF THE BARREDBACK PHEASANT [*SYRMATICUS HUMIAE* (HUME)][1]

G. W. H. Davison[2]

(*With two text-figures*)

The Barredback Pheasant, native to north and east Burma, has become common in captivity since 1962. Observations were made over two years on the behaviour of captive individuals in Britain. Published notes on behaviour in the wild are summarized, and followed by notes on comfort movements, agonistic behaviour, sexual displays, nesting and the calls of captive birds.

Introduction

The Barredback Pheasant *Syrmaticus humiae* is found in the wild state through north and east Burma, and in the adjacent parts of Manipur, Yunnan and northern Thailand. Apart from field observations by Beebe (1926), records of this species are confined to short notes mainly in faunistic papers. Some notes on the behaviour of wild birds were given by Stuart Baker (1930). Barredback Pheasants of the western, nominate subspecies became common in captivity in Europe and America after 1962 (Wayre 1969), and this has permitted more detailed observations of their behaviour. Observations were made during 1973 and 1974 on the behaviour of several birds, kept in pairs or trios in outdoor enclosures in Britain.

Description

This is a slightly built pheasant, the male mainly coppery brown with a steel-blue head and neck, a black and white rump, and a long grey tail barred with black and chestnut. Two white bars cross the wing, with a broad patch of steel-blue between them, and a third white bar crosses the scapulars. Around the eye is a scarlet distensible wattle, and above this a white superciliary line. The female is mottled with dull brown, sandy brown and black; a light sandy patch replaces the blue wing-patch of the male. The outer rectrices and the under tail-coverts are chestnut with black and white tips.

Behaviour in the wild

Although Hume (1881) in his original description said that they live from 2500 to 5000 feet elevation, the normally reported altitude limits are higher. The lowest records other than Hume's are at 2750 feet in the valley of the river Toubal in Manipur (Ali and Ripley 1969) and at 4000 feet at Haka and in the Chin Hills, Burma; the highest are at 10,000 feet in the Naga Hills (Stuart Baker 1930) and on Mount Victoria, its most southerly station (Stresemann and Heinrich 1940). They are commoner in the lower parts of this altitudinal range, moving up to the hill tops

[1] Accepted June 1979.

[2] Dept. of Wildlife and National Parks, P.O. Box 611, Kuala Lumpur, Malaysia.

in warm wet weather and lower in cooler dry weather (Drummond 1923), but nests have been found as high as 7000 feet (Stuart Baker 1930). Possibly the higher altitude limits reported since Hume's time reflect human predation in the more accessible lower part of its range.

Barredback Pheasants are forest-edge birds. They are not found in the dense seasonal subtropical forest of the lower hills but in the more open forest higher up. There they are found amongst scrub oak, conifers or mixed woodland, wherever this is interrupted by grassland or dense patches of bracken or dwarf date palm. They frequent rocky hillsides with scrub forest lacking big trees, but are not found in truly open country (Drummond 1923), which suggests that they prefer edge habitats, including the thick growth along streams (Hume 1881). On grassy hillsides broken by rocky outcrops the birds can feed in the open parts while the rocks provide cover and escape by flight down the hillside is easy. They feed during the morning and evening, and retreat to the taller forest during the hottest part of the day and to roost at night.

The degree to which males hold stable territories in the breeding season is uncertain. Males are polygynous and the birds live in small flocks with one adult male and several females. Flocks of upto ten have been seen, which may include young birds (Stuart Baker 1930), but parties of three to five are commoner (Drummond 1923). Solitary males have also been seen, perhaps old birds after all their mates have dispersed to nest, or young males which have not yet acquired a group of females. A crowing call has been mentioned only by Beebe (1926).

In the wild nests have been found from March to May; the clutch size varies from six to ten with a mean of 7.6 (five clutches).

The diet includes acorns, wild raspberries, palm fruits, chestnuts, various unidentified fruits and seeds, and occasional snails, worms and other invertebrates (Drummond 1923, Beebe 1926, Stuart Baker 1930).

Behaviour in captivity

Comfort movements:

Barredback Pheasants often bathe in dry dusty soil, lying on one side and scratching vigorously in the earth with one foot, wriggling on the belly so that dust is worked between the ruffled feathers, and turning on to the other side. They sunbathe lying on one side with one wing and leg stretched out, and often with the tail spread on the same side, both eyes or the eye facing into the sun closed, and the feathers ruffled.

All the plumage is shaken by a rolling body shake, so brisk that the bird appears to stagger on its feet (Fig. le).

The most frequent, unilateral stretching movement involves one leg, lifted from the ground and stretched backwards, and the lowering and stretching of the wing on the same side; the foot of the stretched leg is brushed by the spread primaries or protrudes through them. Both sexes sometimes stretch by spreading the tail laterally and symmetrically. They stretch both wings and the tail by lifting the two closed wings high over the back, so that the carpal joints almost touch, and spreading the tail laterally, a movement which in the Junglefowl *Gallus gallus* has been termed 'bilateral stretching' (Kruijt 1964). Occasionally this movement is accompanied by defecation. The three stretching movements are sometimes performed one after the other in sequence, unilateral stretching, tail stretching and bilateral stretching.

Females sometimes stand in an erect posture

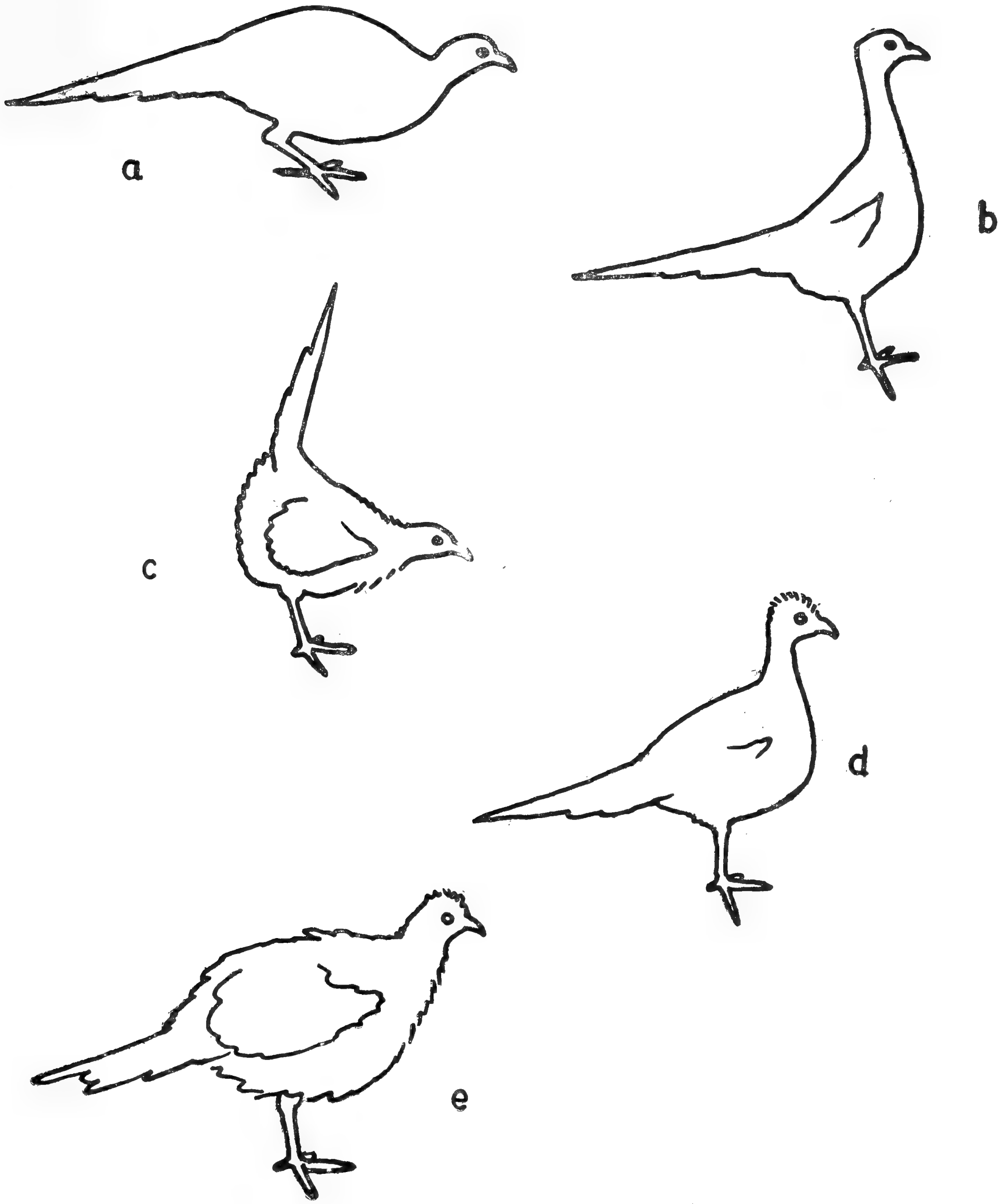


Fig. 1. Agonistic and comfort behaviour of the Barredback Pheasant: (a) crouching in response to a predator overhead, (b) an extreme alert posture, (c) forward-directed threat at a sparrow, (d) alert posture after escaping a predator, with the head feathers ruffled, (e) shaking all the plumage.

with the crown, neck and breast feathers raised, spread the tail laterally, and give two or three flaps of the wings. No call accompanies the wing-flapping.

Agonistic behaviour:

When a potential predator flies high overhead, the bird looks up with one eye by turning its head on one side. On the closer approach of a predator, aerial or terrestrial, the bird may strut about in an alert posture with all the body and wing feathers sleeked, and flick the tail wide open every few seconds, to the accompaniment of a persistent slow clucking. This exposes the chestnut lateral rectrices with their striking black-and-white tips.

Both sexes crouch at the very close approach of an aerial predator, with the feathers sleeked and the head and tail lowered (Fig. la); crouching is often a preliminary to flight. In the contrasting alert posture, the head and neck are stretched up high as the bird looks about, while the tail remains low. In an extreme alert posture the bird appears to lean backwards, with the head held high over the back (Fig. lb): this is accompanied in the male by a long shrill whistle, which degenerates into a loud clucking and may be repeated at intervals of five seconds or longer. The alarm call may be continued for up to 20 minutes after disappearance of the predator.

If it is attacked, a bird will escape either by running, with the head and tail lowered, or with the tail raised but not spread, or by flying a short distance and then running. (Wild birds run from men but fly up into the trees at the approach of a dog. In open areas they escape by flying downhill if approached from above, or by running uphill if approached from below.) After avoiding attack a bird struts about in an alert posture with the crown feathers ruffled, flicking the tail open and clucking loudly (Fig. 1d).

Barredback Pheasants threaten birds of other species, and small mammals, with a forward posture by facing the other animal, lowering the head, raising and spreading the tail and ruffling all the body feathers (Fig. 1c). In this posture the pheasant may run forwards and make lunging movements with the head. Both males and females have a lateral threat display used against conspecifics, very like the male's lateral display to the female during courtship, and it is used between males or by a female trying to avoid a courting male. The wing nearer the other individual is lowered and the farther wing slightly raised, but neither the primaries nor the secondaries are spread. The ruffled rump feathers are exposed, and the tail is spread and tilted towards the other bird. The head is held high and, in males, the wattles are distended. During lateral threat males do not run past one another, but stand, walk slowly along or run side by side. Rival males use lateral and forward threat postures, face one another bill to bill, then leap into the air, flapping the wings and striking with the feet and spurs.

Males advertise their presence to others over short distances with a Wing Whirring display. The male stands erect with the head high and the face wattles distended, the tail lowered and fanned, and whirrs the wings vigorously through a narrow arc for one to five seconds. The upright posture reveals the rich brown underparts, and the sound of the beating wings can be heard for over 30 metres. Wing Whirring is usually performed on a mound or slight rise in the ground, or from a perch on a stump or fallen log, and particular sites are used repeatedly. No loud crow is associated with Wing Whirring, but at high intensity there is a very quiet clucking, much quieter than the sound produced by the wings and hence probably insignificant as a signal. This advertising

display is most often performed in the spring. It is often given soon after the male descends from his roost in the morning, reaches a peak within an hour or two, and gradually decreases in frequency through the rest of the day. When two males are in close proximity they Wing Whirr frequently, facing one another if they are in view; and the sound of one male Wing Whirring often induces another male to do so. Wing Whirring is sometimes given in response to loud noises such as thunder, and after disturbance by a potential predator while still walking round in an alert posture. The short range over which this is an effective signal suggests that in the wild state males may not be strictly territorial but perhaps use the display when wide-ranging flocks approach one another.

Sexual displays:

In captivity displays which appear to be sexually motivated are commonest in March and April, about the time of egg-laying. In courtship feeding or 'Tidbitting' (Domm 1927), the male slightly distends his face wattles and pecks at a small object, a pebble or a twig or a bit of food on the ground, repeatedly picking it up and dropping it while calling with a gentle high-pitched clucking. The female then usually runs forward to the male and pecks at whatever is on the ground.

Lateral and Frontal displays have been described by Davison (1975). Lateral display by a male to a female resembles the lateral threat used between males, but the head is held lower (Fig. 2a). The face wattles are distended, obscuring the white eyebrows, the nearer wing is lowered and the farther wing slightly raised, exposing the white bars and blue patches on the wings and the ruffled black and white feathers on the rump. The tail is spread and tilted towards the female. In the Lateral posture the male runs in arcs before the female, always turning away at the end of each run, whereas rival males walk or run side by side and usually, though not always, turn towards one another when changing direction.

On occasion one captive male during lateral display suddenly veered towards the female, spreading first the primaries of his nearer wing, then of both wings (Fig. 2b). The tail was raised and fully spread, and directed forwards, not tilted to one side. In this posture the head was surrounded by the white and blue wing markings (Fig. 2c). The male faced the female and made rocking movements, lunging forwards with the bill and jerking the tail upwards. This display closely resembled forward-directed threat (cf. Davison 1976). Frontal displays of Elliot's Pheasant *Syrmaticus ellioti* and the Mikado Pheasant *S. mikado* have been mentioned by Delacour (1951).

When the female crouches, the male approaches in an erect posture with his face wattles distended and the nape feathers raised into a peak. He mounts the female by Highstepping (Wood-Gush 1971), and sometimes grasps the female's nape in his bill during copulation. No distinct post-copulatory displays were seen, but one female preened immediately after copulation.

Nesting:

Captive females nest on the ground, beneath a shrub or in thick grass if this is available. The nest is a slight hollow in the ground enlarged by scraping with the feet, simply lined with a few twigs or dead leaves, or whatever material lies within reach of the incubating female, who inserts the nest material around her breast and flanks by Sideways-building (Harrison 1967). The amount of nest material thus accumulated continually increases as incubation proceeds. Laying occurs every second day and, as in the Crestless Fireback *Lophura erythrophthalma* (Jarvis and Med-

way 1969) and the Great Argus *Argusianus argus* (pers. obs.), takes place in the early evening; three eggs were laid by a captive female at 16:45h, 17:10h and 17:30h on alternate days. There is evidence that young females lay smaller clutches than older ones, since a female in her first season laid only three eggs whereas the normal clutch is six or more. Until the clutch is complete the female roosts off the ground. Incubation is by the female alone.

Captive birds in Britain lay in late March

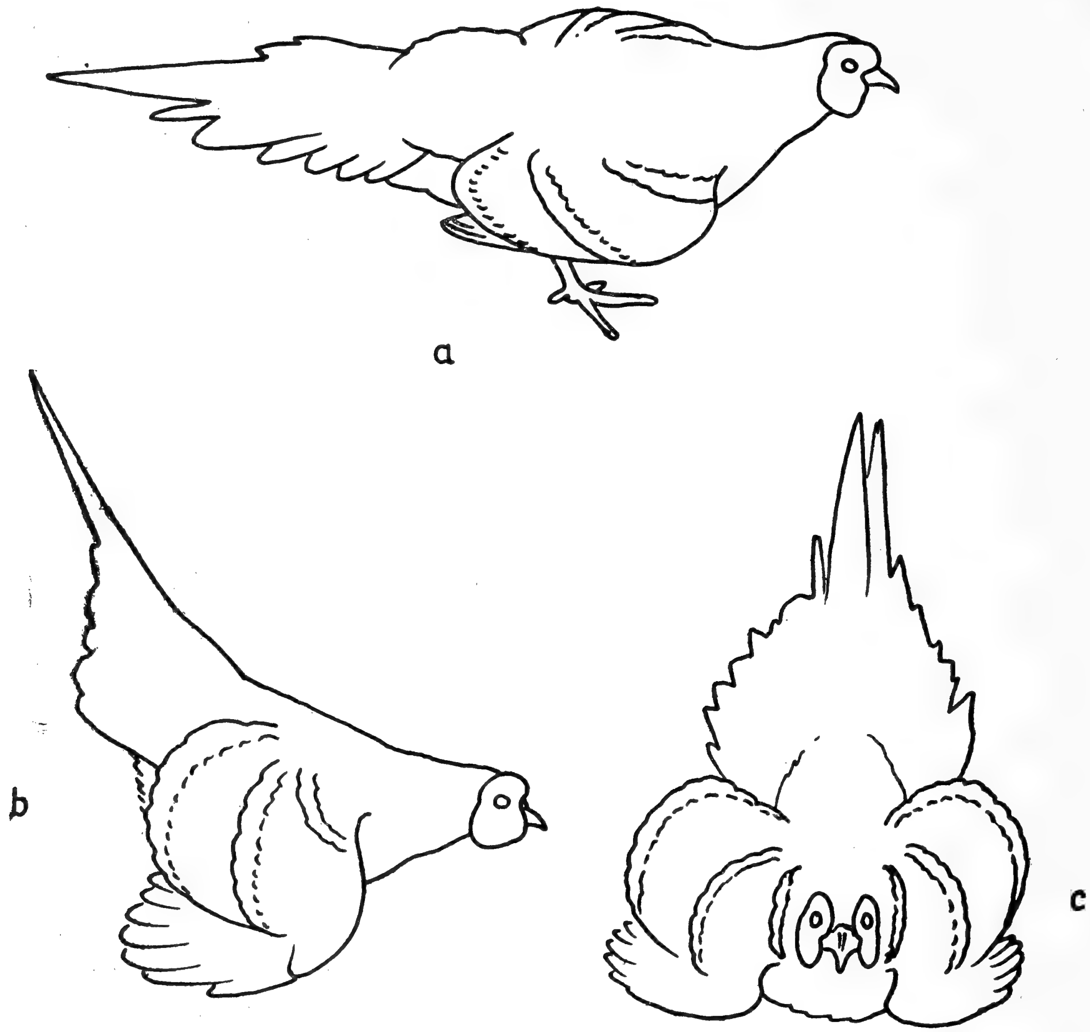


Fig. 2. Sexual displays of the male Barredback Pheasant: (a) Lateral display, seen from the female's point of view, (b) Frontal display seen from the side, showing the spread primaries and raised tail, which from this position is flicked forwards repeatedly, (c) Frontal display from the female's point of view, showing the broad fan of plumage with white wing-bars circling the head.

or in April, and in the wild state nests have been found from mid March to mid May (Beebe 1926, Stuart Baker 1930). The eggs are dull creamy white, the inside of the shell white, and in size they average 47×35.5 mm (average of five). Wild-laid eggs average 48.7 (51.5-46.0) × 35.3 (37.5-33.2) mm (Stuart Baker 1930). The egg weight is approximately 33g, a full clutch therefore weighing from 198 to 330 g, and the egg volume 30 cm^3 (average of three).

Voice:

Males and females have a loud single *chuck*, which appears to be a contact note, and a loud clucking *buk, buk*..., a contact note used between members of a group, which is the most frequently heard call. When birds are frightened this clucking becomes louder and higher-pitched, and an insistent clucking is also used as an aggressive note between males about to fight. The screeching alarm call has been described above, and a similar but shorter screech was heard from a captive female when she was attacked by a male. A loud hiss is given by the male in high intensity lateral display as he runs past the female and is accompanied by an apparent expansion of the body. Beebe (1926) mentioned a harsh crow, heard regularly from wild birds morning and evening, but this was not heard from captive males.

Discussion

The behaviour of the Barredback Pheasant is no more specialized than that of its congeners *S. ellioti* and *S. mikado* or various other pheasants of the subtropical zone (Delacour 1951). This appears to be a typical polygynous pheasant living in small groups with a single adult male and several females, with their attendant young at the appropriate season. Since the male seems to lack a loud advertising crow, but has a Wing Whirring display which has the same function over a shorter distance, like various species of *Lophura* but unlike *Phasianus,* the area used by the flock may be small, or fluid and not strictly defended against other groups. Morphologically, however, the Barredback Pheasant and its congeners closely resemble *Phasianus.*

All the comfort movements, and all the reactions to predators except the alert posture with whistle (Fig. 1b), closely resemble those of other game-birds (cf. Wood-Gush 1971). As in Anseriformes (Johnsgard 1965) these aspects of behaviour give little clue to systematic relationships. The Lateral display resembles that of its congeners *S. ellioti* and *S. mikado,* as well as that of *Phasianus* except in small details. That of *Phasianus* is slower and the primaries of the nearer wing are spread (Kruijt 1963). Spreading of the primaries, which was seen in the male Barredback Pheasant as he veered towards the female, contrasts with the displays of most pheasant genera, for example (those which are morphologically most similar to *Syrmaticus* and *Phasianus*) of *Lophura, Catreus* and *Chrysolophus.* The Frontal display differs from the Frontal displays of *Polyplectron, Argusianus, Pavo* and *Lophophorus* which have been analysed by Schenkel (1956), and may be an aberrant behaviour pattern induced by the constrained conditions of captivity.

References

ALI, S. AND RIPLEY, S. D. (1969): Handbook of the birds of India and Pakistan. Vol. 2. Bombay.

BEEBE, W. (1926): Pheasants, their lives and homes. London.

DAVISON, G. W. H. (1975): Frontal display in the Bar-tailed Pheasant. *Pheasant Trust ann. Rep. 1974*: 25-26.

——— (1976): The function of tail and under tail-covert patterns in pheasants. *Ibis 118*: 123-126.

DELACOUR, J. (1951): The Pheasants of the World. London.

DOMM, L. (1927): New experiments on ovariotomy and the problem of sex inversion in the fowl. *J. exp. Zool. 48*: 31-73.

DRUMMOND, J. G. P. (1923): The Burmese Barred-back Pheasant (*Phasianus humiae burmannicus*). *J. Bombay nat. Hist. Soc. 29*: 562-563.

HARRISON, C. J. O. (1967): Sideways-throwing and sideways-building in birds. *Ibis 109*: 539-551.

HUME, A. O. (1881): *Callophasis humiae*, Sp. Nov. Mrs. Hume's Pheasant. *Stray Feathers 9*: 461-467.

JARVIS, C. AND MEDWAY, LORD. (1969): Sideways throwing and associated reproductive behaviour in the Crestless Fireback Pheasant *Lophura erythrophthalma. Pheasant Trust ann. Rep. 1968*: 13-14.

JOHNSGARD, P. (1965): Handbook of waterfowl behaviour. London.

KRUIJT, J. P. (1963): Notes on wing display in the courtship of pheasants. *Avicult. Mag. 69*: 11-20.

——— (1964): Ontogeny of social behaviour in Burmese Red Junglefowl (*Gallus gallus spadiceus*). Leiden.

SCHENKEL, R. (1956): Zur Deutung der Balzleistungen einiger Phasianiden und Tetraoniden. Erster Teil. *Orn. Beobacht. 53*: 182-201.

STRESEMANN, E. AND HEINRICH, G. (1940): Die Vögel des Mount Victoria. *Mitteil. Zool. Mus. Berlin 24*: 151-264.

STUART BAKER, E. C. (1930): The Game Birds of India, Burma and Ceylon. Vol. 3. Bombay.

WAYRE, P. (1969): A Guide to the Pheasants of the World. London.

WOOD-GUSH, D. G. M. (1971): The Behaviour of the Domestic Fowl. London.

INDO-PHILIPPINE SPECIES OF *DISOPHRYS* FOERSTER (HYMENOPTERA: BRACONIDAE)[1]

SHAMA BHAT[2]

(*With seventeen text-figures*)

Two new species of *Disophrys* Foerster *viz.*, *D. indica* and *D. latiabdominalis* are described. A key to the Indo-Philippine species is provided. Three known species from Philippines and two known species from India are redescribed.

INTRODUCTION

Disophrys Foerster is a large genus, world wide in distribution. It belongs to the subfamily Agathidinae of the family Braconidae. Brullé (1846), Cameron (1903, 1904, 1905, 1907, 1908), Szépligeti (1908), Roman (1913), Enderlein 1918 (1920) and Turner (1922) have described a large number of species from the Oriental Region. Baltazar (1963) has transferred some of the species of this genus to other genera of Agathidinae. According to Shenefelt (1970) 23 species have been reported from the Oriental Region but this paper deals with Indo-Philippine species only. I have compared the new species described here with all the Oriental species of this genus. Nine species are known from India and Philippines and

TABLE 1

COMPARISON OF *Disophrys* FOERSTER AND *Zelomorpha* ASHMEAD

Characters	*Zelomorpha* Ashmead	*Disophrys* Foerster
1. Fore tibial spur	curved and more pointed (Fig. 9)	less curved and less pointed (Fig. 11)
2. Longer middle tibial spur	1.0 $\times$ as long as middle basitarsus (Fig. 10)	0.5-0.6 $\times$ as long as middle basitarsus (Fig. 12)
3. Eyes	strongly rounded and weakly emarginate (Fig. 1)	moderately rounded and not emarginate (Fig. 2)
4. Malar space	less, 1.0 $\times$ the basal width of mandible	3-4 $\times$ the basal width of mandible
5. Interocellar distance	1.0 $\times$ the ocello-ocular distance (Fig. 1)	0.3-0.5 $\times$ the ocello-ocular distance (Fig. 2)
6. Submediellan cell	0.33 $\times$ the mediella	0.5 $\times$ the mediella

[1] Accepted May 1978.

[2] Department of Zoology, University of Delhi, Delhi-7.

among these *Disophrys sissoo* Wilkinson has been transferred to *Zelomorpha* Ashmead. The co-type of *D. sissoo,* matches with *Zelomorpha amplarga* Gupta & Bhat, 1972 and *Zelomorpha amplarga* is relegated as a synonym of *Zelomorpha sissoo* (Wilkinson). Both the genera, *Disophrys* and *Zelomorpha* are confusing. The distinguishing characters of the two genera are given in the Table 1.

Genus **Disophrys** Foerster

Disophrys Foerster, 1862, *Verh. Naturh. ver. Preuss. Rheinlande, 19*:246. Type *Ichneumon inculcator* Linnaeus; monobasic and original designation.

Brachyropalum Kriechbaumer, 1894, *Berl. Ent. Z., 39*:312. Type: *Brachyropalum pallidum* Kriechbaumer; monobasic.

Coccygidium Saussure, 1892, In Grandidier: *Hist. Phys. Nat. Polit. Madagascar,* 20: pl. 15, fig. 27. Type: *Coccygidium luteum* Saussure; monobasic.

Pseudoagathis Kriechbaumer, 1894, *Berl. Ent. Z., 39*:65. Type: *Pseudoagathis calabarica* Kriechbaumer; monobasic.

The main distinguishing characters of this genus are: Face not rostriform; frontal depression bordered by frontal and marginal carinae; facial tubercles pointed; notauli shallow or deep; mesopleural furrow distinct and transversely carinated; propodeum areolated, propodeal spiracle elongated; submediellan cell 0.5× the mediella; fore tibial spur not curved as in *Zelomorpha* (Figs. 9, 10, 11 & 12); longer middle tibial spur 0.5-0.7× as long as middle basitarsus; claws of fore and middle legs bifid; ovipositor very short or barely exerted.

Type-species: *Ichneumon inculcator* Linnaeus

Disophrys shows marked affinity with *Zelomorpha* Ashmead in the following characters: Presence of frontal and marginal carinae; distinct notauli; presence of mesopleural furrow; facial tubercles pointed; areolated propodeum; propodeal spiracle elongate and short ovipositor. But it can be separated by the characters given in the Table 1.

It shares certain characters with *Euagathis* Szépligeti in the bifid fore and middle claws, areolated propodeum, elongate propodeal spiracle, notauli and mesopleural furrow distinct and short ovipositor. But *Euagathis* can be separated by the absence of frontal and marginal carinae on frons, weak facial tubercles and the submediellan cell being 0.33× the mediella.

KEY TO THE INDO-PHILIPPINE SPECIES OF *Disophrys*

1. Head and thorax densely punctate, especially face, meso-and metapleurae; abdomen and hind leg usually black, if yellow then the entire body yellowish 2
   Head and thorax shiny, smooth or with sparse punctures especially on subpleural area and metapleurum; abdomen and hind leg usually yellowish (except in *indica* sp. nov. and *rufoplagiata,* where it is black) 6
2. Entire body yellowish to yellowish-red; apical 0.5 of fore wing brown and basal 0.5 yellowish-hyaline with a brown stigmal spot reaching hinder end of the fore wing; smaller species, 7-8 mm long; notauli deep with a few carinae; middle lobe of mesoscutum distinctly raised; ocellar triangle depressed; mesopleural furrow with short transverse carinae 3
   Vertex, occiput, mesoscutum (except in *coelaspis*), abdomen and hind leg dark brown to black; wings either dark brown or basal 0.33 yellowish-hyaline and apical 0.66 dark brown without any stigmal spot; large species, 9-12 mm long; notauli shallow with long transverse carinae; middle lobe of mesoscutum depressed; ocelli small, ocellar triangle raised; facial tubercles strongly protruding; mesopleural furrow with long transverse carinae 4
3. Hind tibia black; head covered with brown pubescence; wings hyaline with yellowish tinge. Sri Lanka and India...*kandyensis* (Cameron)
   Apex of hind tibia brown; head covered with golden yellow pubescence; apical 0.5 of wings

brown and basal 0.5 yellowish-hyaline with a brown stigmal spot. India.. *subfasciata* (Brulle)

4. Scutellum with an apical carina, lateral carinae absent, (Fig. 16); basal 0.33 of wings yellowish-hyaline and apical 0.66 dark brown; frons, middle of vertex and occiput black; all the mesoscutal lobes with black spots; propodeum as in fig. 5. Philippines......*insignis* Roman
   Scutellum carinated on lateral sides and apex, with a longitudinal carinae (Fig. 15) dividing scutellum into two parts; wings dark brown; frons and vertex yellowish-red (except in *philippinensis* Roman); mesoscutum either wholly black or yellowish-red; propodeum as in figs. 6 & 8 5
5. Head and thorax yellowish-red; hind coxa long, 2 × as long as wide; mesoscutal lobes smooth; Propodeum with strong carinae (Fig. 6). Philippines .... *coelaspis* Roman
   Vertex, occiput and mesoscutum black; hind coxa thick, 1.5 × as long as wide; mesoscutal lobes with big punctures; propodeum with weak carinae (Fig. 8). Philippines................................. *philippinensis* Roman
6. Wings entirely dark brown; abdomen and hind leg dark brown. 7
   Basal 0.33-0.5 of wings yellowish-hyaline and apical 0.5-0.6 light brown to dark brown. 8
7. Head, palpi and mesopleurum black; mesopleurum with a reddish spot; coxae, trochanters and femora thickly covered with white pubescene. India......... *rufoplagiata* (Cameron)
   Head, palpi and thorax yellowish-red; coxae, trochanters and femora sparsely pubescent. India .... *indica* sp. nov.
8. Fore wing without any brown stigmal spot; apical few tergites of abdomen dark brown; vertex and genae brown; propodeum with indistinct carinae; abdomen long and narrow. India .... *dehraensis* Turner
   Fore wing with a brown stigmal spot; abdomen yellowish to yellowish-red; vertex yellowish-red; propodeum with distinct carinae; abdomen very wide (Fig. 13).................9
9. Second cubital cell not emitting a short vein; vertex and occiput yellowish; mesopleural furrow weakly carinated; hind coxa 2 × as long as wide; first tergite longer than wide at apex; body length 8 mm. India..*laticeps* (Cameron)
   Second cubital cell emitting a short vein; vertex and occiput brownish; mesopleural furrow moderately carinated; hind coxa 1.0 × as long as wide; first tergite as long as (1.0 ×) wide at apex (Fig. 13); body length 13-14 mm. .... *latiabdominalis* sp. nov.

1. **Disophrys kandyensis** (Cameron)

Agathis kandyensis Cameron, 1905, *Spolia Zeylan., 13*: 77. Type ♂ Sri Lanka: Kandy (London).

Disophrys kandyensis: Dover, 1925, *Ent. Mitt., 14*: 40.

Agathis abuensis Cameron, 1907, *Z. Syst. Hymenopt. Dipterol., 7*: 465. Type ♂, India: Abu (London). Syn. by Dover, 1925.

Agathis oya Cameron, 1905, *Spolia Zeylan., 3*: 78. Types ♀♂, location unknown. Syn. by Dover, 1925.

This species resembles *subfasciata* (Brullé) but it can be distinguished by a set of characters given in the key.

2. **Disophrys subfasciata** (Brullé) (Figs. 11 & 12)

Agathis subfasciata Brullé, 1846, *Hist. Nat. Insects Hym., 4*: 489. Type ♀, India (Paris),

Disophrys subfasciata: Dover, 1925, *Ent. Mitt., 14*: 40.

This species is characterized by having the apex of hind tibia black, head with golden yellow pubescence and apical 0.5 of wings brown and basal 0.5 yellowish-hyaline with a brown stigmal spot reaching hinder end of the fore wing.

Male and *female*: Face densely punctate; facial tubercles promient; face and clypeus 1.0 × as long as wide; malar space sparsely punctate, 2 × the basal width of mandible and 0.5 × the eye height; scape short and stout, 1.6 × as long as wide; vertex and occiput smooth; ocelli big; interocellar distance 0.35 × the ocello-ocular distance and 2 × the distance

between median and lateral ocelli; mesoscutum shiny, closely punctate, its middle lobe raised; notauli deep, very weakly and transversely carinated; prescutellar depression with three longitudinal carinae; scutellum densely punctate with an apical carina; mesopleurum sparsely punctate; subpleural area densely punctate; mesopleural furrow deep, moderately carinated, metapleurum densely punctate with a few zigzag carinae; submetapleural ridge prominent; propodeum strongly carinated, its apicolateral tubercles blunt; first and second intercubiti parallel without emitting any short vein, nervulus misad of the basal vein; hind tibial spur 6.0 × as long as hind basitarsus; abdomen smooth, first tergite 1.4 × as long as its apical width.

Yellowish-red. Flagellum, band on scape, apex of hind tibia and tarsus brown; apical 0.5 of wings brown and basal 0.5 yellowish hyaline with a brown stigmal spot reaching hinder end of the fore wing.

Length: ♀, 8-8.2 mm; fore wing 8 mm. ♂, 8-8.2 mm; fore wing 8 mm.

Specimens examined: 4♀♀, 4♂♂. INDIA: TAMIL NADU: Coimbatore, 1♀, 2♂♂, vii.1951, P. S. Nathan (Townes). BIHAR: Ranchi, Namkum, 3♀♀, 2♂♂, iv.1957, V. K. Gupta Coll., 1♂, 23.iv.1956, C. Tirky Coll. (Gupta).

Distribution: India: Tamil Nadu and Bihar.

3. **Disophrys insignis** Roman (Figs. 2, 5 & 16)

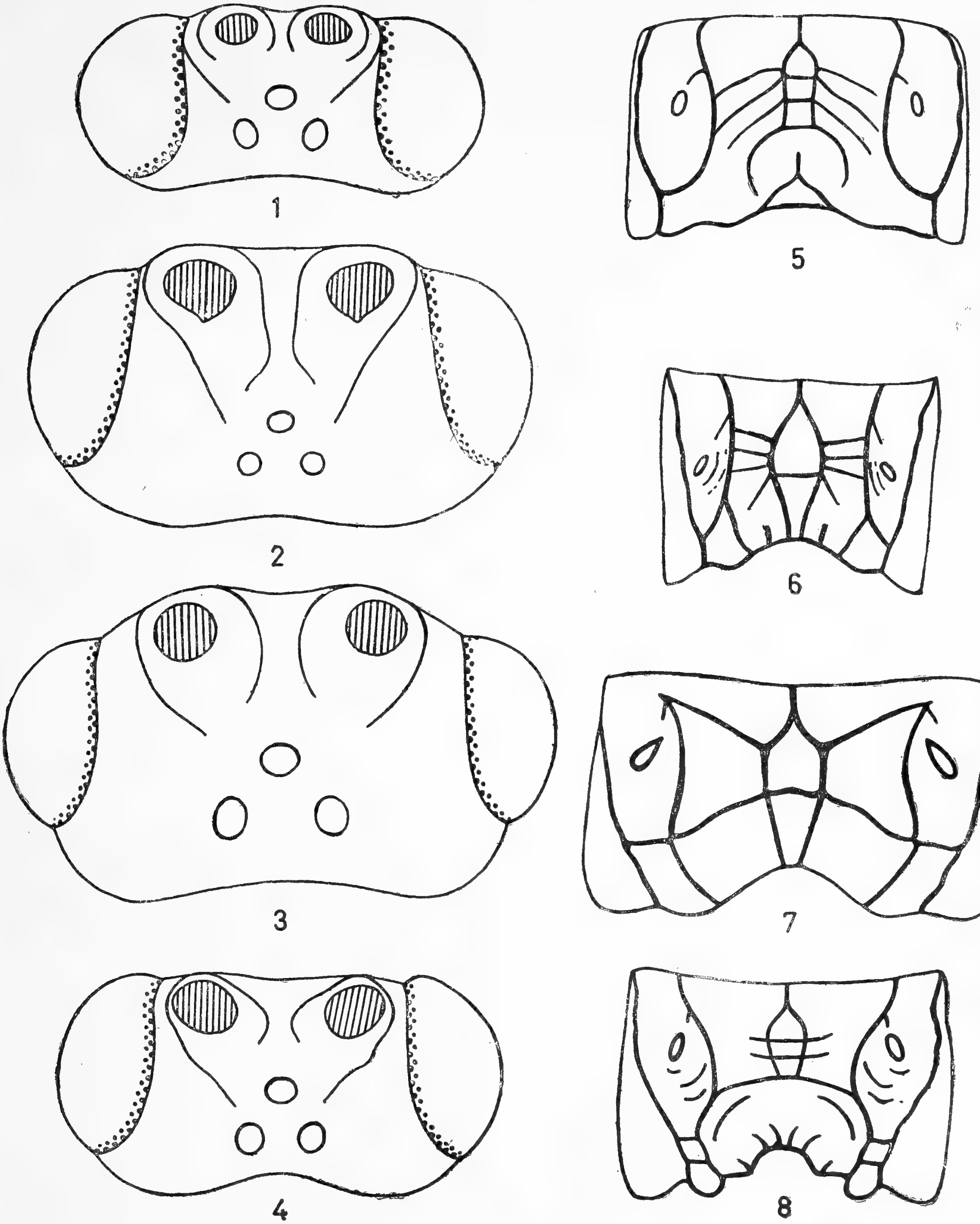
Disophrys insignis Roman, 1913, *Ark. Zool.*, 8 (15): 32. Type ♀, Philippines: Butunnan (Stockholm).

This species can be recognized by the following set of characters: Scutellum with only apical carina, without any median longitudinal carina; middle of frons, vertex and occiput black; mesoscutal lobes with black spots; basal 0.33 of wings yellowish-hyaline and apical 0.66 dark brown without any brown stigmal spot.

Female: Face and clypeus densely punctate, 1.0 × as long as its maximum width; malar space 2 × the basal width of mandible and 0.5 × the eye height; eyes moderately rounded (Fig. 2); facial tubercles strongly protruding; scape 2 × as long as wide; marginal carina of frons wavy, reaching up to the lateral ocellus (Fig. 2); ocelli small, ocellar triangle raised, interocellar distance 0.2 × the ocello-ocular distance and 1.0 × the distance between median and lateral ocelli; vertex strongly punctate; mesoscutum sparsely punctate, punctures big, its lobes depressed, notauli shallow with transverse carinae mingling with the middle lobe of mesoscutum; prescutellar depression with three longitudinal carinae; scutellum strongly punctate with an apical carina reaching on lateral corners (Fig. 16); mesopleurum smooth with a few big punctures; subpleural area and metapleurum densely punctate; mesopleural furrow wide strongly and transversely carinated; propodeum as in fig. 5; first and second intercubiti not parallel, second intercubitus roundly curved emitting a short vein, nervulus misad of basal vein; longer hind tibial spur 0.5 × as long as hind basitarsus; abdomen smooth, first tergite 2.3-2.5 × as long as its apical width, second tergite squarish, 2 + 3 tergites 1.5 × as long as wide, all tergites with a row of apical hairs.

Yellowish-red. Frons, middle of vertex, occiput, antennae, spots on mesoscutal lobes, mesosternum, hind leg and abdomen dark brown to black; basal 0.33 of wings yellowish-hyaline and apical 0.66 dark brown without any brown stigmal spot.

Male: It resembles the female in all essential features but differs in having mesoscutum more strongly punctate; subpleural area and



Figs. 1-4. Dorsal view of head of: 1. *Zelomorpha* sp. (*Disophrys sissoo* Wilkinson); 2. *D. insignis* Roman; 3. *D. latiabdominalis* sp. nov.; 4. *D. coelaspis* Roman. Figs. 5-8. Propodeum of: 5. *D. insignis* Roman; 6. *D. coelaspis* Roman; 7. *D. latiabdominalis* sp. nov.; 8. *D. philippinensis* Roman.

metapleurum more densely punctate, punctures not big; vertex either yellowish-red or only ocellar region light brown; mesoscutal lobes without any black spots; hind coxa and femur either yellowish-red or light brown.

Length: ♀, 13.5 mm; fore wing 12 mm. ♂, 13 mm; fore wing 12 mm.

Specimens examined: 4♀♀, 2♂♂. PHILIPPINES: MINDORO: Victoria, Alcate, 1♀, 11.iv.1954, H. M. & D. Townes (Townes); MINDANAO: Dapitan, 1♀, 1♂, C. F. Baker (Washington); Pollo Island, 1♀, C. F. Baker (Washington), MINDANAO: Mati, Davao, 1♀, iv.1927, M. C. Gram (Washington); LUZON, 1♂, vi.1909, J. C. Thompson (Washington).

Distribution: Philippines.

4. **Disophrys coelaspis** Roman (Figs. 4, 6 & 15)

Disophrys coelaspis Roman, 1913, *Ark. Zool.*, 8 (15): 33. Type ♀, Philippines: Manat (Stockholm).

This species is similar to *philippinensis* Roman but differs by having yellowish-red head and thorax. The hind coxa is 2× as long as wide and mesoscutal lobes almost smooth.

Male and *female*: Face and clypeus shiny, densely punctate, 1.3× as long as its maximum width; facial tubercles strongly protruding; malar space densely punctate, 2× the basal width of mandible and 0.6× the eye height; scape long and stout, 2.7× as long as wide; marginal carina straight (Fig. 4); ocellar triangle raised, interocellar distance 0.6× transverse stout carinae; prescutellar depression between median and lateral ocelli; vertex densely punctate; mesoscutum depressed, with a few big punctures, notauli shallow with long transverse stout carinae; prescutellar depression with three longitudinal carinae; scutellum smooth with raised lateral and apical carinae (Fig. 15); mesopleurum smooth; subpleural area and metapleurum closely punctate; mesopleural furrow wide with 8-9 long transverse carinae, anterior carinae longer than the posterior; propodeum with strong median and lateral longitudinal carinae (Fig. 6); basal and apical areas without any transverse carinae; first and second intercubiti not parallel, second roundly curved emitting a short vein, nervulus misad of basal vein; longer hind tibial spur 0.5× the hind basitarsus; abdomen smooth, long and narrow, first tergite 2.5× as long as its apical width, second tergite longer than broad, 2+3 tergites 2-2.5× as long as wide.

Yellowish-red. Antennae, abdomen and hind leg (except hind coxa) dark brown; wings entirely brown with yellowish tinge at base.

Length: ♀, 10.5-11 mm; fore wing 10 mm. ♂, 10.5 mm; fore wing 10.5 mm.

Specimens examined: 1♀, 2♂♂. PHILIPPINES: MINDANAO, 1♀, 2♂♂, (date not given) C.F. Baker (Washington).

Distribution: Philippines.

5. **Disophrys philippinensis** Roman (Figs. 8 & 17)

Disophrys philippinensis Roman, 1913, *Ark. Zool.*, 8(15): 34. Types ♀♂, Philippines (Stockholm).

This species is recognized in having vertex, occiput and mesoscutum brown to black. The hind coxa is thick and stout, 1.5× as long as wide, mesoscutal lobes with big punctures and propodeum with weak and indistinct carinae.

Female: Face and clypeus densely punctate, 1.1× as long as wide; facial tubercles raised and broadly separated; scape 2× as long as wide; malar space densely punctate, 2.5× the basal width of mandible and 0.5× the eye height; ocelli small, ocellar triangle raised, interocellar distance 0.33× the ocello-ocular distance and 1.0× the distance between median and lateral ocelli; vertex sparsely punctate, punctures big; mesoscutum sparsely and

strongly punctate, notauli shallow with long transverse carinae; prescutellar depression with three longitudinal carinae; scutellum sparsely punctate with lateral and apical carinae, a median longitudinal carina (Fig. 17) reaching up to the basal end of scutellum; mesopleurum sparsely punctate; subpleural area closely punctate; mesopleural furrow wide with 9-10 long transverse carinae; metapleurum densely punctate; propodeum moderately carinated, basal and apical areas with a few transverse carinae (Fig. 8); first and second intercubiti parallel, emitting a short vein, nervulus misad of basal vein; longer hind tibial spur 0.45× as long as hind basitarsus; abdomen smooth, long and narrow, first tergite 2.5-2.8× as long as wide.

Yellowish-red and black. Head (except vertex), pronotum, mesopleurum, subpleural area, fore and middle legs yellowish-red; antennae, vertex, mesoscutum, propodeum, metapleurum, abdomen and hind leg brown to black; wings dark brown, stigma and veins brown, a hyaline spot at the base of stigma.

Male: It resembles the female in all essential characters but some of the males differ in colour e.g. vertex broadly black; anterior part of pronotum, mesopleurum and subpleural area brown.

Length: ♀ 12-12.2 mm; fore wing 10 mm. ♂, 11.5-12 mm; fore wing 10 mm.

Specimens examined: 14♀♀, 11♂♂. PHILIPPINES: MINDORO: Victoria, Alcate, 4♀♀, 3♂♂, 7-11.iv.1954, H.M. & D. Townes (Townes); NEGROS: Negros Oriental, Mt. Canlaon, 1097.28 m, 2♀♀, 30.iv.1953, H. M. & D. Townes; Tagaytay, 6♀♀, 8-20.ii-xi.1952, Townes family (Townes); MINDANAO, Davao, 2♀♀, 2♂♂ (date not given), C. F. Baker (Washington); MANILA, 2♂♂, 28.ii.1953, Townes family (Townes); Los Banos, 1♂, 13.xii.1953, H. & M. Townes (Townes); Leyte, Utap, 2♂♂, 17.xi.1957 (Townes); MINDANAO, Zamboanga, 1♂, (date not given), C. F. Baker (Washington).

Distribution: Philippines.

6. **Disophrys rufoplagiata** (Cameron)

Agathis rufoplagiata Cameron, 1904, *Z. Syst. Hymenopt. Dipterol., 4*:5 Type ♂, India: Sikkim (London).

Disophrys rufoplagiata Dover, 1925, Ent. Mitt., *14*: 40.

This species is very close to *D. indica* sp. nov. but can be separated by the characters given in key.

7. **Disophrys indica** sp. nov.

This species is characterized by having head, palpi and thorax yellowish-red. The coxae, trochanters and femora of all legs are sparsely pubescent.

Male and *female*: Face and clypeus with very minute punctures and sparsely pubescent, 1.1× as long as wide; facial tubercles weakly raised and confluent; malar space 2× the basal width of mandible and 0.5× the eye height scape long, 2.5× as long as wide; ocelli large, ocellar triangle depressed, interocellar distance 0.33× the ocello-ocular distance and 2× the distance between median and lateral ocelli; vertex shiny and smooth; mesoscutum smooth with a few scattered punctures on its lateral lobes, its middle lobe raised, notauli distinct with 7-8 strong transverse carinae; prescutellar depression with one longitudinal carina; scutellum smooth with an apical carina only; mesopleurum smooth, subpleural area sparsely punctate; mesopleural furrow distinct, wide with 9-10 strong transverse carinae; metapleurum rugosely punctate; propodeum moderately carinated, basal area incomplete with three transverse carinae; first and second intercubiti not parallel, second intercubitus emitting a short vein, nervulus misad of the basal vein;

longer hind tibial spur 0.5× as long as hind basitarsus; abdomen smooth, long and narrow, first tergite 2.5× as long as its apical width, 2+3 tergites 2.4× as long as wide.

Yellowish-red and black. Head, thorax and fore and middle legs yellowish-red; antennae, propodeum, metapleurum, abdomen and hind leg dark brown to black; wings dark brown with a hyaline spot at the base of stigma.

Length: ♀, 10 mm; fore wing 9.8 mm. ♂, 10.8 mm; fore wing 10 mm.

Holotype ♀ INDIA: UTTAR PRADESH: Dehra Dun, 600 m, 8.vi.1966, D. T. Tikar No. T 264. *Allotype* ♂, same data as the holotype (Gupta).

Distribution: India: Uttar Pradesh.

8. **Disophrys dehraensis** Turner

Disophrys dehraensis Turner, 1922, *Ann. Mag. Nat. Hist.*, (9) *10*: 277. Type ♀, India: Dehra Dun (London).

This species is distinguished by the absence of brown stigmal spot in the fore wing and apical few abdominal segments dark brown. The vertex is light brown and propodeum with two weak incomplete carinae.

Female: Face shiny, very minutely and sparsely punctate; face and clypeus 1.0× as long as wide; malar space 1.5× the basal width of mandible and 0.4× the eye height; facial tubercles weak and blunt; scape short, 1.6× as long as wide; vertex shiny and smooth; ocelli big, ocellar triangle depressed; interocellar distance 0.5× the ocello-ocular distance and 2× the distance between median and lateral ocelli; mesoscutum smooth, its middle lobe long and raised, notauli distinct and smooth; prescutellar depression with one longitudinal carina; scutellum smooth, without any apical and lateral carinae; meso- and metapleurae and subpleural area smooth; mesopleural furrow narrow with short transverse carinae; propodeum with two weak longitudinal carinae; first and second intercubiti not parallel, without emitting any short vein, nervulus misad of basal vein; longer hind tibial spur 0.5× as long as hind basitarsus; abdomen smooth, first tergite wide at apex, 1.0× as long as wide at apex, 2+3 tergites 1.0× as long as wide.

Yellowish-red. Antennae, frons, vertex, genae and apical few tergites dark brown; basal 0.5 of wings yellowish-hyaline and apical 0.5 brown without any stigmal spot in the fore wing, stigma entirely brown, basal veins yellowish and apical veins brown.

Male: Unknown.

Length: ♀, 11.5 mm; fore wing 9.5 mm.

Specimen examined: INDIA: BIHAR: Ranchi, 1♀, 1957, G.W. Angalet (Washington).

Distribution: India: Bihar and Uttar Pradesh from literature.

9. **Disophrys laticeps** Cameron

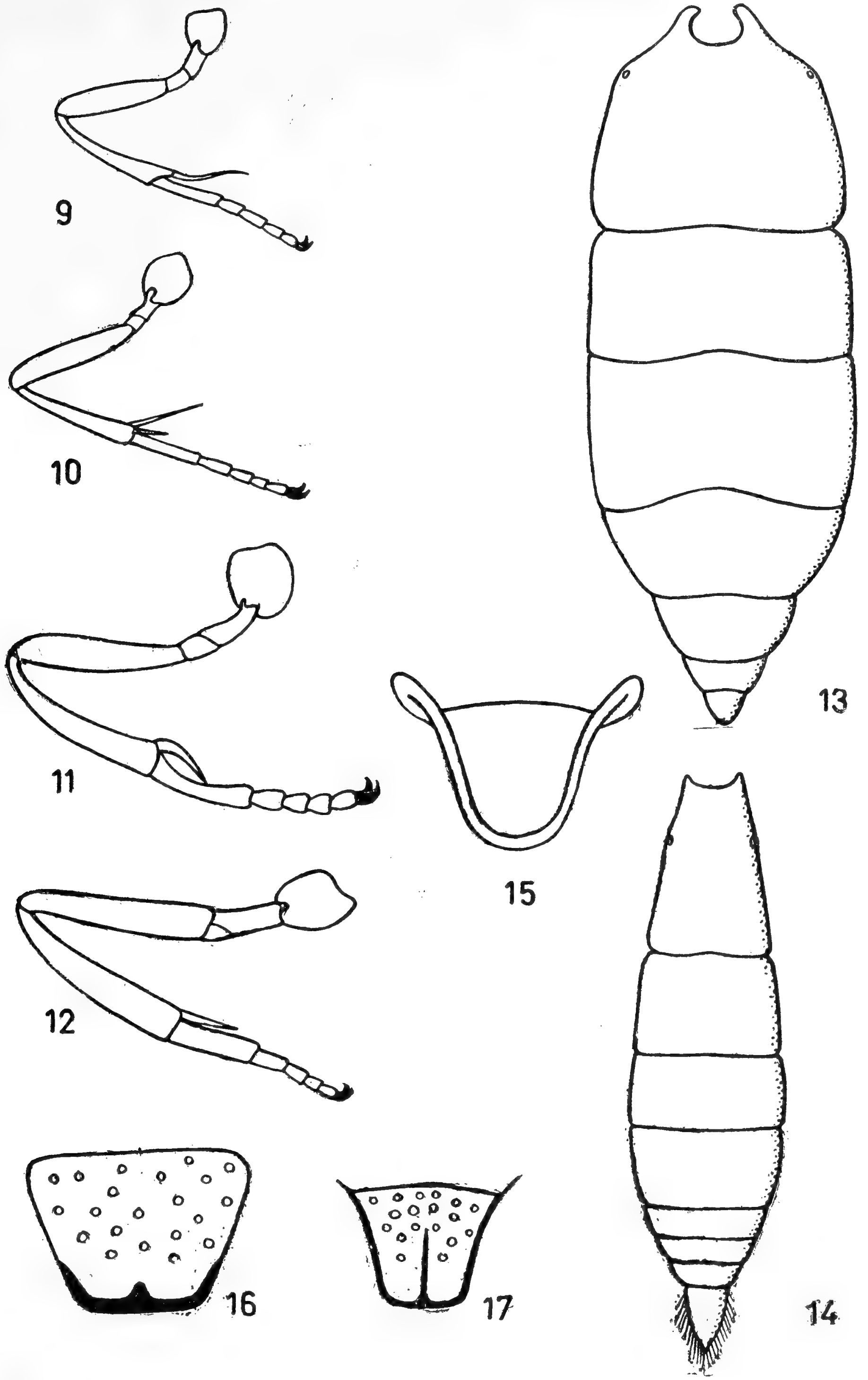
Disophrys laticeps Cameron, 1907, *J. Bombay nat. Hist. Soc.*, *17*: 585. Type ♂, India: Abu (London).

This species is similar to *latiabdominalis* sp. nov. in having wide abdomen and yellowish-red body but it can be separated by the characters given in key. This species has been described from the type locality only.

10. **Disophrys latiabdominalis** sp. nov.
(Figs. 3, 7 & 13)

This species can be recognized in having vertex and occiput brown and the second cubital cell emitting a short vein. The mesopleural furrow is moderately and transversely carinated and the hind coxa being as long as broad.

Male: Face minutely and sparsely punctate, especially on lateral sides; face and clypeus 1.0× as long as wide; facial tubercles distinct and separated; malar space 2× the basal width of mandible and 0.5× the eye height; scape 2× as long as wide; vertex smooth; ocelli big,



Figs. 9-12. Legs of: 9. Fore leg of *Zelomorpha* sp. (*Disophrys sissoo* Wilk.); 10. middle leg of *Zelomorpha* sp. (*Disophrys sissoo*); 11. fore leg of *D. subfasciata* (Brullé); 12. Middle leg of *D. subfasciata* (Brullé). Figs. 13-14. Abdomen of: 13. *D. latiabdominalis* sp. nov.; 14. *Zelomorpha* sp. (*Disophrys sissoo* Wilk.). Figs. 15-17. Scutellum of: 15. *D. coelaspis* Roman; 16. *D. insignis* Roman; 17. *D. philippinensis* Roman.

ocellar triangle depressed, interocellar distance 0.33× the ocello-ocular distance and 2× the distance between median and lateral ocelli; mesoscutum smooth, its middle lobe broad and depressed, notauli distinct with 3-5 stout transverse carinae; prescutellar depression with 5 longitudinal carinae; scutellum smooth with an apical carina and with a small longitudinal carina reaching mid height of scutellum; mesopleurum smooth; subpleural area and metapleurum very sparsely and minutely punctate; mesopleural furrow wide, transversely carinated; propodeum strongly carinated (Fig. 7), basal area pentagonal and apical area longer than broad, all areas on propodeum smooth; hind coxa 1.0× as long as wide; first and second intercubiti not parallel, second intercubitus curved and emitting a short vein, nervulus misad of basal vein; abdomen smooth, very wide, first tergite 1.0× as long (Fig. 13) as wide at apex, 2+3 tergites 1.2× as long as wide.

Yellowish-red. Antennae, vertex, occiput and hind tarsus brown to dark brown; basal 0.66 of wings yellowish-hyaline and apical 0.33 brown with a brown stigmal spot reaching hinder end of fore wing, stigma yellowish with brown tinge, basal veins yellow and apical veins brown.

Female: Unknown.

Length: ♂, 13.5 mm; fore wing 13 mm.

Holotype ♂, INDIA: TAMIL NADU: Coimbatore. xi.1956, P. S. Nathan (Ottawa).

Distribution: India: Tamil Nadu and Madhya Pradesh.

The name of species is derived from the Latin word, *latus* = broad, referring to its broad abdomen.

References

Baltazar, C. R. (1963): New combinations in some Indo-Australian Agathidinae and description of a new genus. *Acta Hymenopt.*, Tokyo, *2*: 1-4.

Brulle, A. (1946): Histoire Naturelle des Insects: Hymenopteres. Paris. Roret, *4*: 689.

Cameron, P. (1903): Descriptions of new genera and species of Hymenoptera taken by Mr. Robert Shelford at Sarawak, Borneo. *J. Straits Brch. Asiatic Soc.*, *39*: 89-181.

——————— (1904): Descriptions of new genera and species of Hymenoptera from India. *Z. Syst. Hym. Dipt.*, *4*: 5-15.

——————— (1905): A third contribution to the knowledge of the Hymenoptera of Sarawak. *J. Straits Brch. Asiatic Soc.*, *44*: 93-168.

——————— (1907): On the parasitic Hymenoptera collected by Major C. G. Nurse in the Bombay Presidency. *J. Bombay Nat. Hist. Soc.*, *17*: 578-597.

——————— (1908): Description of new species of Braconidae from Borneo. *Dt. Ent. Z.*, 1908: 687-694.

Enderlein, G. [(1918) 1920]: Zur Kenntnis au-Bereuropaischer Braconiden. *Arch. Naturgesch.*, *84*A (11): 51-224.

Gupta, V. K. and Bhat, S. (1972): On the Oriental species of *Zelomorpha* Ashmead (Hymenoptera: Braconidae). *Oriental Ins.*, *6*(4): 449-457.

Roman, A. (1913): Philippinische Schlupfwespen aus dem Schwedischen Reichsmiseum 1. *Ark. Zool.*, *8*(15): 1-51.

Shenefelt, R. D. (1970): *Hymenopterorum Catalogus*, (6) *3*: 307-428.

Szepligeti, G. V. (1908): Jacobson'sche Hymenopteren aus Semarang (Java), Evaniiden, Braconiden und Ichneumoniden. *Notes Leyden Mus.*, *29*: 209-260.

Turner, R. E. (1922): New Evaniidae and Braconidae in the British Museum. *Ann. Mag. Nat. Hist.*, (9) *10*: 270-281.

MOVEMENTS OF *BANDICOTA BENGALENSIS* (GRAY 1873) AND *TATERA INDICA* (HARDWICKE 1807) AS REVEALED BY RADIO TELEMETRY[1]

G. W. Fulk,[2] A. C. Smiet[4] and
A. R. Khokhar[3]

(*With two text-figures*)

Movements of 10 *Bandicota bengalensis* and one *Tatera indica* were monitored with radio telemetry over a two-month period. The *Tatera* had a home range 275 metres long. All the bandicoots had smaller home ranges, confining their movements to part of a 0.4-hectare field. Two adult females had ranges which enclosed the ranges of their young but did not overlap with each other. An adult male had a larger home range overlapping with all other bandicoots. Eventually all bandicoots seemed to make one-way long-distance movements away from the home field. The distance of four of these one-way movements were recorded and ranged from 340 to 640 metres. Increased density in the home field was thought to have stimulated these residents to move away.

Introduction

Both *Bandicota bengalensis* and *Tatera indica* are known to be pests in several crops in Pakistan. In lower Sind, *Bandicota* is an especially serious pest in rice (Wagle 1927; Greaves *et al.* 1977). Although several aspects of the biology of *Bandicota* have been studied, little is known about its movements in agricultural lands. Frantz (1973) studied its movements in an urban environment and found the maximum range diameter to be 146 metres. The testing of new radio-telemetry equipment was used as an opportunity to study the movements of *Bandicota* and *Tatera* in an agricultural area in lower Sind, with the emphasis on *Bandicota.*

[1] Accepted April 1978.

[2] C/o. New England College of Optometry, 424 Beacon Street, Boston, Mass. 02115, U.S.A.

[3] Vertebrate Pest Control Centre, P.O. Box No. 8401, University Campus, Karachi 32 (Pakistan).

[4] FAO Associate Expert, P.O. Box 69, Ambon, Maluku, Indonesia.

Study area

A large plot of land (about 400 hectares), located 5 kilometres south of Gharo village (24° 44′N, 67° 36′E) in Thatta District, Sind, supported a high bandicoot population. The area was divided into fields, about 0.4 hectare in size, all of which had been left fallow for at least one year. Herbaceous plant cover was generally quite dense, but there were occasional bare patches of saline soil. Seeds of *Coix lacrima-jobi* provided conspicuous and abundant food. Other common plants were *Scirpus maritimus, Typha angustifolia, Desmostachya bipinnata,* and *Cressa cretica.* Some fields contained sprouting rice stubble left from the 1976 rice season.

Materials and methods

The telemetry equipment used was manufactured by AVM Instrument Company

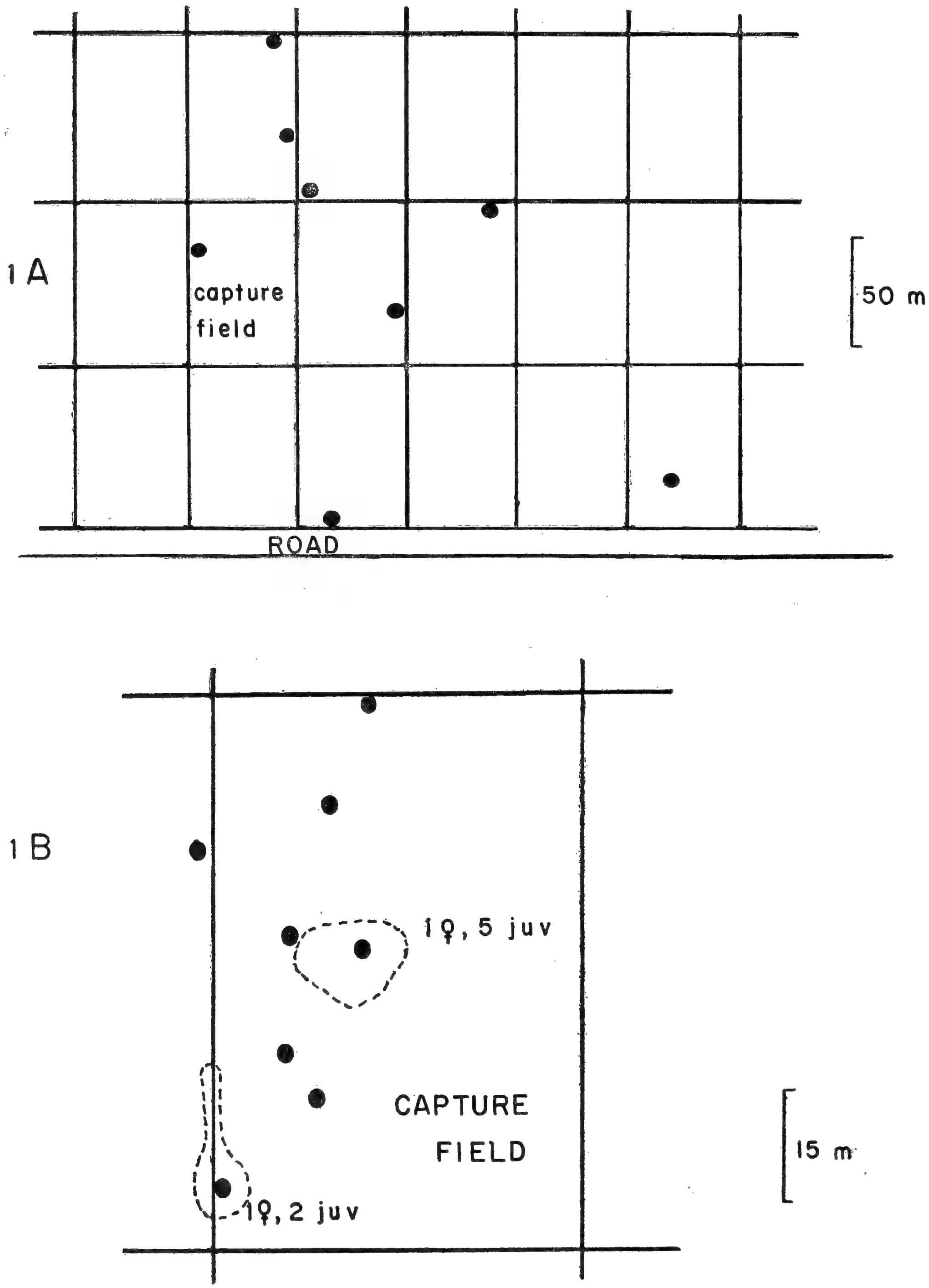


Fig. 1. A) Radio fixes of one *Tatera*, B) Radio fixes (ovals) of an adult male *Bandicota bengalensis* in the capture field and home ranges (dotted lines) of one adult female with five juveniles and of another adult female with two juveniles.

(Champaign, I11. USA) and consisted of a receiver, hand-held yagi antenna and small transmitters fitted on neck collars. Two different sized transmitters were used weighing 3 and 9 grams. Theoretical life of the transmitters was over three months and we were able to receive signals from a distance of 50 to 250 metres depending on conditions. Locations (fixes) of transmitter-fitted animals were accurate to the nearest metre. With this antenna we had to approach the animal to make a fix.

On 20 November 1977, 10 *Bandicota bengalensis* and 1 *Tatera indica* were trapped from a single field in the study area. These animals were brought to the laboratory, anesthetized with an appropriate dose of 6% Sodium Thiopental, and fitted with a radio-collar. After a recovery period of at least 24 hours, the animals were released at their capture points. On 26 November, all animals were back in the field.

From 22 November until 1 February, 18 trips to the study area were made, at least one per week. In general, during each trip we tried to fix animals at least three times with 4-hour intervals between fixes.

RESULTS

Two types of movements were observed. Movements that seemed to be part of the animal's daily behaviour are here called home range movements, following the definition of Burt (1943). One-way movements that resulted in a change of home site are called long-distance movements.

Tatera indica

Only home range movements were observed in the single *Tatera* studied (Fig. 1A). This animal often was not located (Table 1), probably due to the depth of its burrows which greatly reduced the strength of the transmitter signal. The longest axis of its home range was 275 metres. Large distances were sometimes moved in a short time. On 28 November it moved 70 metres in less than 4 hours and on 30 November 100 metres in the same time interval.

Bandicota bengalensis

Most bandicoots were located in the original capture field during every search from 22 November to 7 December (Table 1). Home ranges of the 10 bandicoots fell into three groups (Fig. 1B). One group, consisting of one adult female (No. 9) and five juveniles (Nos. 10 through 14), had overlapping home ranges near the centre of the field. Another adult female (No. 7) and two juveniles (Nos. 5 and 6) had overlapping ranges along the small embankment bordering the field. The single adult male (No. 2) had a larger home range covering the home ranges of the other bandicoots. During the night of 30 November, the adult male shifted its home range to a field 300 metres away from the capture field (Fig. 2). It remained in the new location until 7 December after which it could not be located.

Between 7 and 9 December, seven of the remaining nine bandicoots could not be located. Intensive live trapping in the capture field resulted in the capture of the two animals (Nos. 5 and 6) already known to be there and 16 young less than a month old. An intensive search with the radio receiver of more than a 10-hectare area around the field failed to locate any of the animals, suggesting that animals had moved several hundred metres away. This suggestion was partly confirmed on 16th January, when one (No. 12) of the disappeared animals was located at a distance of 640 metres from the capture field (Fig. 2).

Radios on the two animals (Nos. 5 and 6) taken with live traps were working on 12 December, the date of recapture. The collars

TABLE 1

DATES WHEN ANIMALS WERE LOCATED WITH RADIO RECEIVER DURING A TWO-MONTH STUDY

Rat	Number	Sex	Weight	Date of search																		LDM	ORL
				22 Nov	26 Nov	28 Nov	30/1 Nov Dec	3/4 Dec	7/8 Dec	9/16 Dec	19 Dec	24 Dec	31 Dec	2/3 Jan	7/8 Jan	12 Jan	14/15 Jan	16 Jan	17 Jan	25 Jan	1 Feb		
Tatera	4	M	135	+	0	+	+	0	+	0	+	+	0	0	0	+	–	–	–	–	–	–	275
Band	2	M	240	+	+	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0	340	68
,,	5	F	45	+	+	+	+	+	+	+	+	+	+	+	+	+	0	+	–	–	–	450	35
,,	6	F	65	+	+	+	+	+	+	+	0	0	0	0	0	0	0	+	0	0	0	460	26
,,	7	F	180	+	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0	–	47
,,	9	F	175	–	+	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0	–	16
,,	10	F	90	–	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0	–	13
,,	11	F	60	–	+	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0	–	16
,,	12	M	70	–	+	+	+	+	+	0	0	0	0	0	0	0	0	+	0	0	0	640	12
,,	13	F	75	–	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0	–	12
,,	14	M	75	–	+	+	+	+	0	0	0	0	0	0	0	0	0	0	0	0	0	–	32

+=animal located, 0=animal not located, – =animal known not to be inthe field, LDM = long distance movement, ORL= observed home range length.

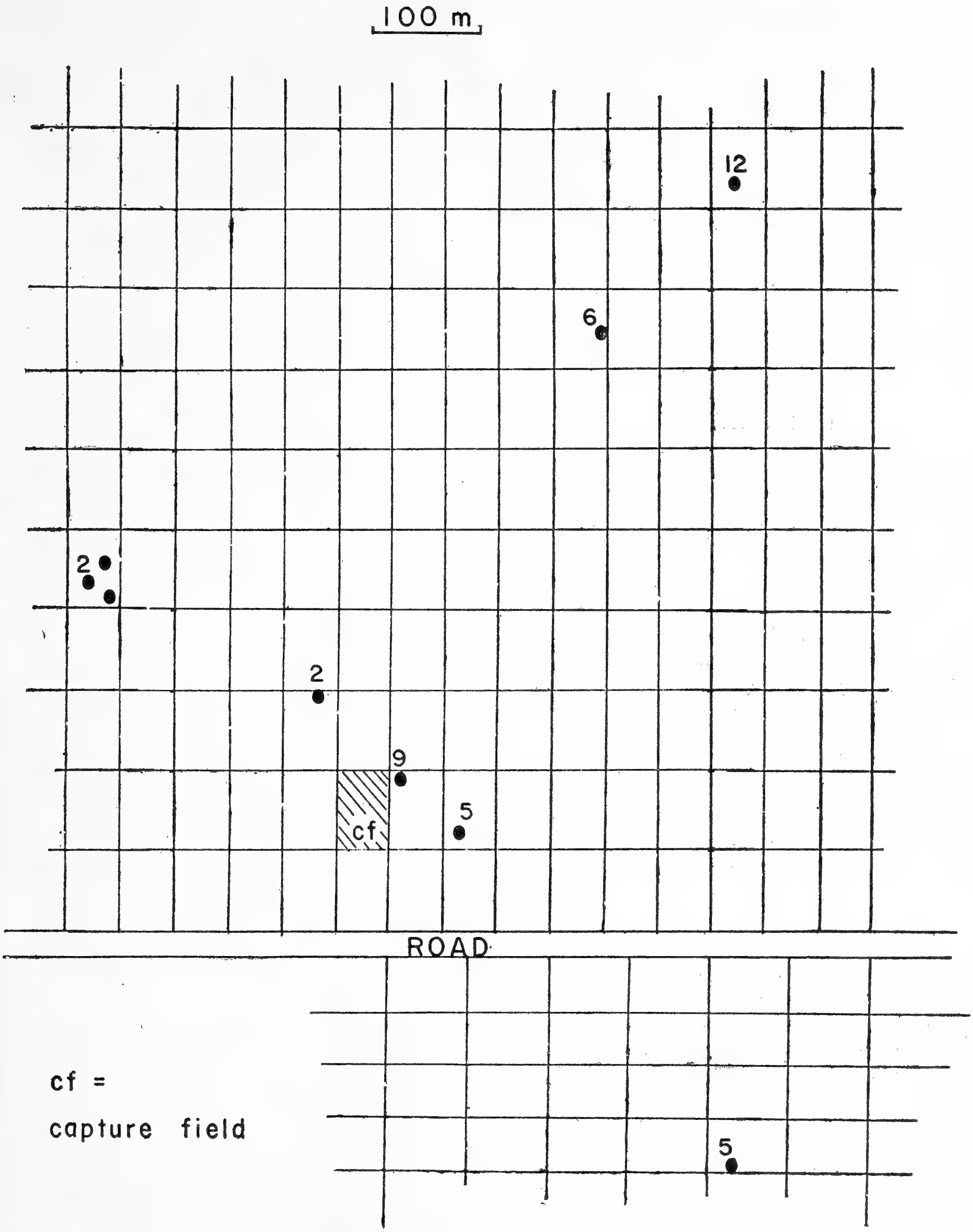


Fig. 2. Radio fixes of five *Bandicota bengalensis* outside the capture field; numbers refer to individual animals as in Table 1.

were enlarged, since the animals had grown, and animals released in the capture field. Animal No. 6 disappeared but was finally found on 16 January 460 metres from the capture field (Fig. 2). Animal No. 5 set up residence in a nearby field where it remained until 14 January when this field was flooded by irrigation water. This animal could not be found on 14 or 15 January. On 16 January it was found active in the daytime and was observed to move 300 metres in two hours. It was captured by hand 450 metres from the capture field in the afternoon of 16 January.

Discussion

The home range length (275 metres) of the single *Tatera* seems to be quite large compared to that of most small mammals (see literature reviews in Frantz 1973; and French *et al.* 1975). In contrast, during the first week of the study, the 10 bandicoots had smaller home ranges, about the size which is often reported for other rodents.

Long distance movements of more than 300 metres away from the home field were recorded for four bandicoots, two males and two females. It seemed likely that the disappearance of the other six bandicoots was due to similar migrations. Of course, the possibility of predation or technical failure of the transmitters could not be excluded.

It was not known what might have stimulated these animals to leave the home field. Most disappeared on or near the same date. There were no apparent changes in the habitat. Live trapping to recover the missing animals showed that the bandicoot density was greatly increasing due to recruitment of young. Perhaps this increased density stimulated residents to leave the field.

The failure to locate six of the 10 bandicoots could have been due to dead transmitters or predation. However, we feel it was more likely that at least some animals moved out of the searched area. This would mean they moved one kilometre or further. The ability of *Bandicota bengalensis* to move over long distances in search of a home site is an adaptation for survival in crop lands where seasonal changes are great.

Acknowledgements

We wish to thank Tausif Akhtar for his help with field work and all the staff of the Vertebrate Pest Control Centre who assisted us. This project was sponsored by the Food and Agriculture Organization of the United Nations and by the Agriculture Research Council of the Government of Pakistan.

References

Burt, W. M. (1943): Territoriality and home-range concepts as applied to mammals. *J. Mammal.* *24*: 346-352.

Frantz, S. C. (1973): Behavioural ecology of the lesser bandicoot rat, *Bandicota bengalensis* (Gray), in Calcutta. Ph.D. Dissertation, John Hopkins University, Baltimore, 222 pp.

French, N. R., Stoddart, D. M. & Bobet, B. (1975): Patterns of demography in small mammal populations. *In* Small Mammals, their Productivity and Population Dynamics, Golley, F. B., Petrusewicz, K. & Ryszkcwaki, L. (eds.) Cambridge University Press. 451 pp.

Greaves, J. H., Choudhry, M. A. & Khan, A. A. (1977): Pilot rodent control studies in rice fields in Sind, using five rodenticides. *Agro-Ecosystems 3*: 119-130. Elsevier Scientific Publ. Company, Amsterdam.

Wagle, P. V. (1927): The rice rats of lower Sind and their control. *J. Bombay nat. Hist. Soc.* *32*: 330-338.

HYDROPHYTIC VEGETATION OF COURTALLUM, SOUTH INDIA[1]

K. K. N. NAIR[2]

(*With two text-figures & a map*)

This paper attempts to present an outline of the angiospermic aquatic vegetation of Courtallum, Tamil Nadu, India. It covers a discussion of the varied habitats of the plant group in the area, an ecological classification, a table giving the relative distribution of each species, a study of their phenology and certain field observations on the vegetation type.

INTRODUCTION

Courtallum (Kuttalam), the well-known area of botanical interest on the Western Ghats of Tamil Nadu State lies between 8° 50′ and 9° 0′ N. and 77° 10′ and 77 20' E., about 86 kilometres from Tirunelveli town and about 7 kilometres from Tenkasi railway station. It is a few miles south of Achenkovil and Aryankauv Pass of the Western Ghats, connecting this portion of the country to Kerala. Courtallum is situated on the eastern side of the Western Ghats facing the Aryankauv Pass and is bounded by Kulathurpuzha and Papanasam reserve forests on the west and south sides and the plains of Tenkasi and Shencottah taluks on the eastern and northern sides. Courtallum is dominated by the mountain chains of the Western Ghats, rising to about 1600 metres in height. The place is of repute in South India for its fine water falls, delightful forest scenary, a temple of antiquity and during certain months of the year an exceptionally cool and healthy climate.

[1] Accepted May 1978.

[2] Central National Herbarium, Botanical Survey of India, Howrah 711 103. *Present address*: Central Plantation Crops Research Institute (I.C.A.R.), Kasargod-670 124.

The climate of Courtallum is the 'tropical montane' type and in the climate classification of Thronthwaites and Hare (1953) the area comes under the 'moist subhumid' region. As Courtallum lies opposite to Aryankauv Pass of the Western Ghats, it receives both southwest (June to September) and northeast (November to January) monsoons with a short gap in between. A monthly average rainfall for the last ten years (1965-75) shows that it varies from 1.24 cm in February to 24 cm in July. Normally a total of 100 to 200 cm of rain precipitates annually. In the mountainous environment of Courtallum the hottest months of the year are April and May when the temperature exceeds 38°C in some of the hot, sunny, days. During the hot months, the temperature never goes below 19°C. But in the southwest monsoon period it ranges within 19-34°C. The lowest minimum temperature recorded for the area is 17°C for the last ten years (1965-75). The main soil types of the area are red soils, laterite, black soils and humid soils and their mixtures in various propertions.

To correlate temperature and rainfall data and to record the drought period in Courtallum which is significant in the study of hydro-

phytes, the rainfall and temperature data for the year 1975 is represented monthwise as an Ombrothermic diagram (Fig. 1). While plotting, the scales used is double in the case of temperature (in °C) when compared to rainfall (in mm). In the resulting graph wherever the rainfall curve passes below that of the temperature it indicates the span of the drought period in that year.

Hydrophytes at Courtallum are mainly seasonal and are distributed along the banks of mountain streams, in marshes, ditches, ponds

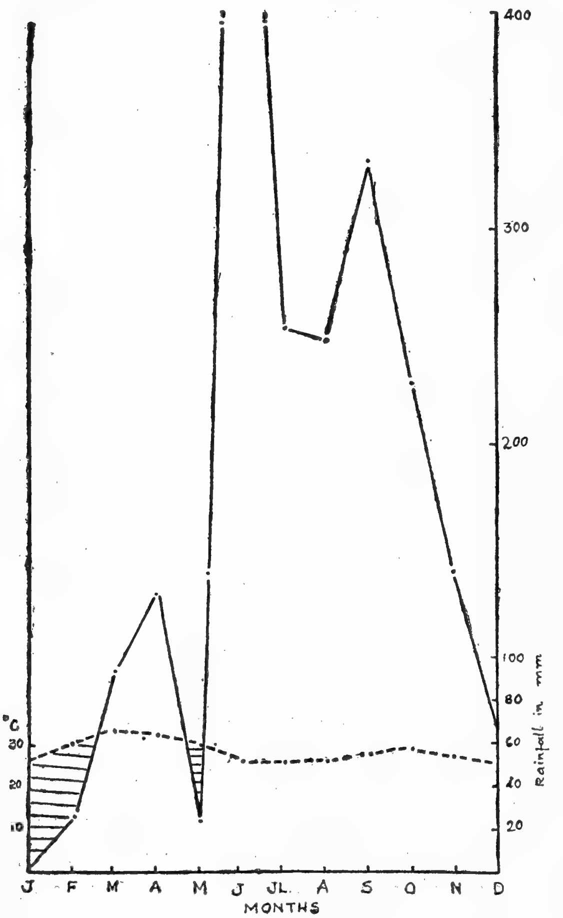


Fig. 1. Ombrothermic diagram for the year 1975.

and such localities. Weaver and Clements (1929, 1938) define hydrophytes as "plants that grow in water, in soil covered with water or in soil that is usually saturated with water". Muenscher (1944) considers true hydrophytes as "those species which normally start in water and must grow for at least a part of their life cycle in water, either completely submerged or emerged" in which he included some 'borderline species' and terrestrial plants along the sides of ponds, lakes and streams which dries up during summer and thus grow in water only for a short period which according to Muenscher (1944) are not truely aquatic. In this connection the definition given by Daubenmire (1947, 1956) is somewhat satisfactory and to him "hydrophytes include aquatics which normally grow in water, and swamp and bog plants which inhabits soil containing a quantity of water that would prove supraoptimal for the average plant". However, the plasticity shown by the members of this group to suit to a variety of aquatic conditions as discussed by Saxton (1924) while elaborating his concept of 'mixed formations' makes it practically impossible to define it precisely and comprehensively. While studying the hydrophytes of Courtallum, especially during the changing seasons this became more evident and several plants survive in a variety of aquatic habitats.

Habitats

The wet banks of the hill streams Chittar, Palayakuttalam Aruvi (Old Courtallum river) and Aindalai Aruvi (Five falls river) (see map) hold the major part of the hydrophytes of Courtallum. In addition to this, the two ponds on the boundary of Courtallum reserve forests, Thippakkulam near Courtallum township and Thamarakulam on the way to Five

falls about 4 kilometres from the former towards the western side of the area and the wet gutters, ditches, puddles etc. formed seasonally harbour a few aquatic and semi-aquatic plants. The habitats characteristic of the plant group in the area are discussed briefly.

Streams and their banks:

Hydrophytes confined to this habitat are mostly those species growing along the banks of those mountain streams traversing the area. Towards the centre of the streams, as there is a constant water current, practically no hydrophyte can flourish except for those free-floating algae, prostrate bryophytes which are fixed to the underlying rocks and species like *Polypleurum stylosum* (Wt.) J. B. Hill which has its roots in the underlying or bordering rock.

In Tekkumalai, along the banks of the river Chittar few aquatic and semiaquatic plants grow. This reduction in the hydrophytic flora is due to the fact that the edge of the streams here is steep leaving little base for foot-hold for the plants. Swampy or marshy conditions do not exist. Rarely sandbanks are formed here and there but with a poor vegetation, that too mainly mesophytic. It is in the course of the stream here that *Polypleurum stylosum* (Wt.) J. B. Hill, grows with its thalloid body attached to the underlying rocks by means of hairs or 'heptera' thus preventing it from being washed away in the current. The plants are restricted to the shallow but swift flowing areas above rocks. Along the sides of the stream here are species like *Commelina ensifolia* R. Br., *C. paludosa* Bl., *Bergia ammanoides* Heyne *ex* Roth, few algae and bryophytes. During monsoon, in several of the canals and marshy spots formed in Tekkumalai, plants like *Oxalis corymbosa* DC., *Biophytum intermedium* R. Br., *Hydrocotyle javanica* Thunb., *Eragrostis gangetica* (Roxb.) Steud., *Paspalum conjugatum* Berg. etc. which are otherwise truly mesophytic growing in semi-hydrophytic conditions.

Along the banks of the river Chittar from Shembagadevi at about 2 kilometres from the foot hills to the Main falls in the vicinity of Courtallum township, a luxuriant growth of aquatic plants occur, as the stream here is shallow and slow-flowing and the banks possess several marshes, puddles and stagnant areas. During monsoon when the stream is full, most of the wet-land species disappear, but as the water level descends, the wet banks and marshes left behind form the natural abode for such plants. Some of the species rather confined to this region are *Drosera burmanii* Vahl, *Xyris pauciflora* Willd., *Cardamine hirsuta* Linn., *Aneilema montanum* (Wt.) Clarke, *Murdannia loriformis* (Hassk.) Rolla Rao *et* Kammathy, *Ludwigia perennis* Linn., *Eriocaulon* sp., *Echinochloa colonum* (Linn.) Lamk., *Lindernia ciliata* (Colsm.) Pennell, *Utricularia graminifolia* Vahl, *Didymocarpus innominatus* Burtt etc. of which the last mentioned plant is truly mesophytic in its natural habitat. In the stagnated pockets of the stream occur floating plants like *Ludwigia perennnis* Linn. with floating roots and *Utricularia* sp. with filiform stem and roots and upright scapes bearing rose coloured flowers. Above Main falls, as the stream slows down, a marsh or puddle system is formed during the summer, where species like *Canscora heteroclita* (Linn.) Gilg, *Hoppea fastigiata* (Griseb.) Clarke, *Xyris pauciflora* Willd., *Elatine triandra* Schkr., *Amischophacelus axillaris* (Linn.) Rolla Rao *et* Kammathy, *Murdannia dimorpha* (Dalz.) Bruck., *Bacopa monnieri* (Linn.) Wettst., *Lindernia crustacea* (Linn.) F. Muell., *Torenia travancorica* Gamble, *Alternanthera sessilis* (Linn.) R. Br. *ex* DC. etc. grow. The most characteristic species of this community is

Canscora heteroclita (Linn.) Gilg, forming elegant stands with green, winged stems and pink flowers. Emergent amphibian hydrophytes like *Limnophila heterophylla* (Roxb.) Benth. exibiting heterophylly is common here in the marsh in almost terrestrial conditions. Several sedges and grasses form the borderline species to those truly aquatic plants here. Below the falls along the sides of the pond in front of Courtallum temple, grow a few aquatics like *Lindernia pusilla* (Willd.) Boldingh, in summer when it is dry. Species like *Hydrolea zeylanica* (Linn.) Vahl, *Sporobolus diander* (Retz.) P. Beauv., *Mariscus compactus* (Retz.) Druce, *M. panicens* (Rottb.) Vahl etc. occupy the sides of the stream on wet ground along with a more characteristic species *Ipomoea pescaprae* (Linn.) R. Br.

During monsoon when the soil between the rocks above Chittaruvi (a bathing spot and cascade about 200 metres west of Courtallum proper) become marshy, *Sopubia delphinifolia* (Roxb.) D. Don with its characteristic green fleshy stem, filiform leaves and prominent rose coloured flowers become gregarious. Unlike several other aquatic species, the plants are erect rooting only basely. Fleshy plants with spreading branches and rooting lower nodes like *Commelina ensifolia* R. Br., *Cyanotis cristata* (Linn.) D. Don, *Bacopa monnieri* (Linn.) Wettst., *Lindernia antipoda* (Linn.) Alston, *Lindernia crustaceae* (Linn.) F. Muell. form a community in this area during rainy season, but in the remaining part of the year they are mesophytic. Except for the few species mentioned, Chittaruvi area is poor in Hydrophytes as also is the Tiger falls area about 200 metres east of Courtallum township, where, in the course of the stream temporary sand beds are formed bordering few semi-aquatic plants like *Polygonum glabrum* Willd. and *Utricularia polygonoides* Edgew. along the banks of the stream. During summer the stream dries, leaving practically no trace of the more hydrophilous plants excepting *Polygonum glabrum* Willd.

At New falls in the interior of the forest above Tiger falls, the aquatic vegetation is more characteristic. As the streamlet here, in the course of its descend, comes down in several steps on the face of the rock with pockets of marshy soil deposited here and there, several aquatic plants like *Eriocaulon quinquangulare* Linn. and *Utricularia graminifolia* Vahl grow. *Utricularia striatula* Sm. grow abundantly carpeting the wet faces of the rock in large patches. Below the falls, in the stagnant water and marshy soil between rocks *Ludwigia octovalvis* (Jacq.) Raven subsp. *sessiliflora* (Mich.) Raven form large clumps with a highly spreading root system, all over the rock covered with soil. *Cyperus tenuispica* Steud. is yet another common wet-land species of the area. The stream is perennial and the aquatic vegetation here flourish in the post monsoon period also.

In the stagnant areas below the reserve forest boundary on the way to Old Courtallum, species like *Polygonum glabrum* Willd. grow in truly aquatic conditions with the vegetative portions almost completely immersed in water, that is an anchored submerged hydrophyte, with the inflorescence emerging above the water level. In the forests around Old Courtallum with several rivulets of the Palayakuttalam Aruvi there are plants like *Pouzolzia pentandra* (Roxb.) Benn., *Bergia ammanoides* Heyne *ex* Roth, *Cyperus pilosus* Vahl etc. in semiaquatic conditions. Aquatic vegetation of this region is quite scanty when compared to that found in other parts of Courtallum.

Along the banks of the river Aindalai Aruvi

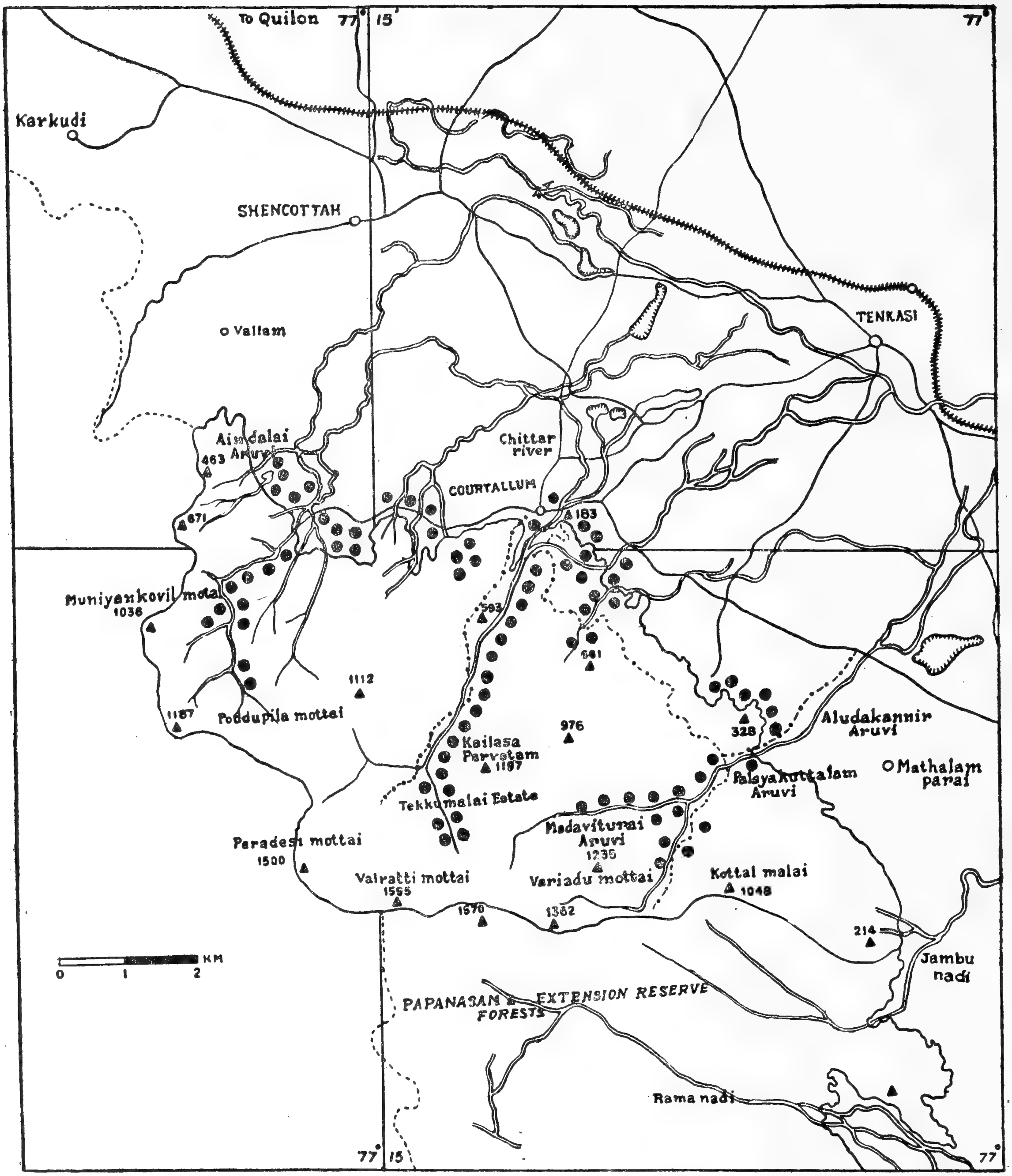
at Five falls and above it, and especially around Swamiar falls in Udayathan estate above, several hydrophytes grow. Even though the stream here is almost perennial, its flow is considerably reduced during summer. The most characteristic growth of this locality is found at Swamiar falls, where the cascading water moistens the surrounding area. A very characteristic species found here is *Epithema carnosum* (G. Don) Benth. which grows only in the ecological niches around mountain streams when such humid conditions exist. The plant is quite curious for its mostly singular large leaves and bluish inflorescence and grows along both sides of the mouth of the falls in the humus soil accumulated in the crevices of the rocks, moistened by the spray from the falls. Surrounding the falls, in the wet soil are plants like *Aneilema montanum* (Wt.) Clarke, *Commelina benghalensis* Linn., *Murdannia zeylanica* (Clarke) Bruck. var. *longicapsa* (Clarke) Rolla Rao *et* Kammathy, *Cyperus castaneus* Willd., *Cyperus iria* Linn., *Fimbristylis ovata* (Burm.f.) Kern, *Paspalidium flavidum* (Retz.) A. Camus, *Lindernia ciliata* (Colsm.) Pennell, *L. antipoda* (Linn.) Alston, *L. crustacea* (Linn.) F. Muell. and *Eragrostis tenella* (Linn.) P. Beauv. which grows as a tufted semiaquatic plant at Swamiar falls is purely mesophytic in dry habitats on the way to Tekkumalai. Similar is the case of *Paspalidium flavidum* (Retz.) A. Camus which is also found here. The rocks bordering Swamiar falls are carpeted by thalloid bryophytes which grow throughout the course of the stream on exposed wet rock surfaces. Below Swamiar falls along the sandbanks formed by the stream here and there, grows *Isachne dispar* Trin., *Fimbristylis bisumbellata* (Forssk.) Bubani and *Eragrostis gangetica* (Roxb.) Steud. which are adapted to semiaquatic conditions though they are mesophytic in several other parts of Courtallum.

Ponds:

Many ponds in Courtallum are mostly temporary and dry up during summer. The period for which they hold water varies according to the month of ceasing of rainfall and the locality where it is situated.

Thippakkulam, the pond in front of Chitrasabhai in the close vicinity of Courtallum temple has been abandoned at present but was once well-maintained and considered to be of religious significance and has a 'gopuram' in its centre surrounded by water. The pond is being reclaimed by dumping wastes and crumpling of side walls and in summer it is almost dry with a marshy bottom. *Pistia stratiotes* Linn. which is a stoloniferous floating herb when the pond is full, gradually descend to the bottom as it dries up and grow gregariously in the marshy soil there. Here and there groups of *Polygonum glabrum* Willd. plants are also common in the marshy bottom of the pond. Other more frequent aquatics here are *Bacopa monnieri* (Linn.) Wettst., *Ammania baccifera* Linn., *Boerhavia diffusa* Linn. and the heterophyllous amphibious hydrophyte *Limnophylla heterophylla* (Roxb.) Benth.

In the outskirts of the forests on the way to Five falls is the pond 'Thamarakulam' which dries up in summer leaving only a marshy bed. The gently sloping marginal zone of this pond remains wet in summer bears wetland species like *Commelina ensifolia* R. Br., *Fimbristylis bisumbellata* (Forssk.) Bubani, *Pycreus globosus* (All.) Reichb., *Dactyloctenium aegyptium* (Linn.) P. Beauv., *Eriochloa procera* (Retz.) C.E. Hubb., *Dopatrium junceum* (Roxb.) Buch.-Ham., *Lindernia antipoda* (Linn.) Alston and such other weeds. The shallow middle zone of the pond which is filled with water during the rainy season forms the habitat for plants like *Nymphaea pubescens* Willd. which are anchored in the bottom of the pond with floating leaves and



●● Map showing the distribution of hydrophytes in Courtallum.

long pedicelled flowers slightly raised above the water level. Floating or rooted aquatics like *Myriophyllum oliganthum* (Wt. *et* Arn.) F. Muell. with submerged leaves, *Hydrilla verticillata* (Linn. f.) Royle with stoloniferous floating plant body and *Aponogeton natans* (Linn.) Engl. *et* E. Krause with floating leaves and stoloniferous rootstock become gregarious when the pond is filled. As the water descends these plants gradually become exposed in the marshy soil where species like *Aeschynomene indica* Linn., *Pycreus globosus* (All.) Reichb. etc. also spread.

Ditches, puddles, canals etc.:

The wet-soil plants growing in several of the moist habitats in the area are grouped under this head and it includes most of the amphibian and less characteristic species of the group. There are a number of shallow bodies of water distributed mostly towards the western part of the area along the outskirts of the forests on the way to Five falls which include small canals, gutters, damp fields, small ditches etc. In such habitats herbs like *Pedalium murex* Linn., *Amischophacelus axillaris* (Linn.) Rolla Rao *et* Kammathy, *Commelina ensifolia* R. Br., *Cyperus tenuispica* Steud., *Fimbristylis bisumbellata* (Forssk.) Bubani, *Dactyloctenium aegyptium* (Linn.) P. Beauv., *Eriochloa procera* (Retz.) C.E. Hubb., *Setaria palmifolia* (Koen.) Stapf, *Dopatrium junceum* (Roxb.) Buch.-Ham., *Lindernia ciliata* (Colsm.) Pennell etc. grow. In the wet soil around the water tank above Courtallum township *Ipomoea pescaprae* (Linn.) R. Br. is a rather common species.

Ecological classification

Weaver and Clements (1929, 1939) in their broad classification of hydrophytes divided them into three groups namely, floating hydrophytes, submerged hydrophytes and amphibious hydrophytes. Prior to them, Agnes Arber (1920) fundamentally differentiated the group into two, i.e. plants rooted in soil and plants not rooted in soil but unattached in water. Based on their contacts with soil, water and air, Daubenmire (1947, 1956) recognised five morphoecologic groups within hydrophytes namely floating hydrophytes, suspended hydrophytes, submerged anchored hydrophytes and emergent anchored hydrophytes, essentially an elaboration of the concept of Weaver and Clements (1929). The group wet-land hydrophytes or marsh plants as recognised by Mirashi (1957), Thomas (1962) and Vyas (1964) is a further segregation of 'emergent anchored hydrophytes' of Daubenmire (1947, 1956) which according to them are plants which are transitional between hydrophytes and mesophytes that grow in wet soil where water table is close to the surface. During these studies on the hydrophytes of Courtallum, it was noted that 'marsh plants' as a group is quite flexible, and plants like *Limnophila heterophylla* (Roxb.) Benth. which grow as typical emergent anchored hydrophytes in Thippakulam when it is full is found in marshy habitats above Main falls during summer. There is no fundamental character by which the group can be differentiated from emergent anchored hydrophytes and hence it is not recognised here as a distinct group. Moreover, in the field, the circumscription of the different groups are nebulous as members belonging to one group can grow in a different habitat characteristic of another group, thus making the concept fallaceous. Some of the more characteristic species coming under the various subgroups under hydrophytes are given below.

Floating hydrophytes

a. FREE-FLOATING TYPE

e.g.: *Pistia stratiotes* Linn., *Myriophyllum*

oliganthum (Wt. *et* Arn.) F. Muell.

b. ANCHORED HYDROPHYTES WITH FLOATING LEAVES

e.g.: *Nymphaea pubescens* Willd., *Aponogeton natans* (Linn.) Engl. *et* E. Krause ;

Submerged hydrophytes :

a. SUSPENDED HYDROPHYTES

e.g.: *Utricularia polygonoides* Edgew.

b. ANCHORED SUBMERGED HYDROPHYTES

e.g.: *Nymphaea pubescens* Willd., *Aponoton natans* (Linn.) Engl. *et* E. Krause, *Polypleurum stylosum* (Wt.) J. B. Hill.

Amphibious hydrophytes :

Plants belonging to this group are described under 'emergent anchored hydrophytes' by Daubenmire (1947, 1956) and also as marsh plants by others. As a group it is not very characteristic and its members can survive in mesophytic conditions also. Such plants are quite common in Courtallum and a few examples are *Polygonum glabrum* Willd., *Aeschynomene indica* Linn., *Pouzolzia pentandra* (Roxb.) Benn., *Ludwigia octovalvis* (Jacq.) Raven subsp. *sessiliflora* (Mich.) Raven, *Bergia ammanoides* Heyne *ex* Roth, *Limnophila heterophylla* (Roxb.) Benth., *Pedalium murex* Linn., *Alternanthera sessilis* (Linn.) R. Br. *ex* DC., *Ammania baccifera* Linn., *Asystasia chelonoides* Nees, *Biophytum intermedium* Wt., *Boerhavia diffusa* Linn., *Canscora heteroclita* (Linn.) Gilg, *Cardamine hirsuta* Linn., *Chlorophytum laxum* R. Br., *Didymocarpus innominatus* Burtt, *Drosera burmanii* Vahl, *Elatine triandra* Schkr., *Hoppea fastigiata* (Griseb.) Clarke, *Utricularia graminifolia* Vahl, *Polygala javana* DC. and several members of Scophulariaceae, Commelinaceae, Cyperaceae and Gramineae.

RELATIVE DISTRIBUTION

The table that follows gives the relative range of distribution of various hydrophytes in the different habitats of Courtallum. Several species like *Polypleurum stylosum* (Wt.) J. B. Hill, *Epithema carnosum* (G. Don) Benth., *Ludwigia octovalvis* (Jacq.) Raven subsp. *sessiliflora* (Mich.) Raven etc. are restricted to particular 'ecological niches' whereas species like *Bacopa monnieri* (Linn.) Wettst., *Commelina benghalensis* Linn. and *Lindernia* sp. flourish wherever moist situations prevail.

TABLE 1

DISTRIBUTION OF HYDROPHYTES IN THE DIFFERENT HABITATS OF COURTALLUM

Name of the species	Habitat							
	S_1	S_2	S_3	S_4	S_5	P_1	P_2	M
Aeschynomene indica Linn.	–	–	–	–	+	–	–	+
Alternanthera sessilis (Linn.) R. Br. *ex* DC.	–	+	–	–	+	–	–	+
Amischophacelus axillaris (Linn.) Rolla Rao *et* Kammathy	–	+	–	–	+	–	–	+

Streams and their banks: S_1—In Tekkumalai; S_2—From Shembagadevi to Main falls; S_3—Chittaruvi, Tiger falls, Old Courtallum falls; S_4—New falls; S_5—Five falls to Swamiar falls.
Ponds: P_1—Thippakkulam; P_2—Thamarakulam.
Puddles, ditches, canals, etc.: M (miscellaneous)

Name of the species	Habitat							
	S_1	S_2	S_3	S_4	S_5	P_1	P_2	M
Ammania baccifera Linn.	–	–	–	–	–	+	–	+
Aneilema montanum (Wt.) Clarke	–	+	–	–	+	–	–	–
Aponogeton natans (Linn.) Engl. *et* E. Krause	–	–	–	–	–	–	+	–
Asystasia chelonoides Nees	–	–	–	–	+	–	–	–
Bacopa monnieri (Linn.) Wettst.	–	+	+	–	+	+	+	+
Bergia ammanoides Heyne *ex* Roth	–	+	+	+	+	–	–	–
Biophytum intermedium Wt.	+	–	–	–	–	–	–	–
Boerhavia diffusa Linn.	–	–	–	–	–	+	–	–
Canscora heteroclita (Linn.) Gilg	–	+	–	–	–	–	–	–
Cardamine hirsuta Linn.	–	+	–	–	–	–	–	–
Chlorophytum laxum R. Br.	–	+	–	–	–	–	–	–
Commelina benghalensis Linn.	+	+	+	+	+	+	+	+
Commelina ensifolia R. Br.	+	–	+	–	+	–	–	–
Commelina paludosa Bl.	+	–	–	–	–	–	–	–
Cyanotis cristata (Linn.) D. Don	–	–	+	–	–	–	–	–
Cyperus castaneus Willd.	–	–	–	–	+	–	–	–
Cyperus exaltus Retz.	–	+	–	–	–	–	–	–
Cyperus iria Linn.	–	–	–	–	+	–	–	–
Cyperus pilosus Vahl	–	–	+	–	–	–	–	–
Cyperus tenuispica Steud.	–	–	–	+	+	–	–	+
Dactyloctenium aegyptium (Linn.) P. Beauv.	–	–	–	–	+	–	–	–
Didymocarpus innominatus Burtt	–	+	–	–	–	–	–	–
Dopatrium junceum (Roxb.) Buch.-Ham.	–	–	–	–	+	–	–	+
Drosera burmanii Vahl	–	+	–	–	–	–	–	–
Echinochloa colonum (Linn.) Link	+	+	–	–	–	–	–	–
Elatine triandra Schkr.	–	+	–	–	–	–	–	+
Eleocharis capitata (Linn.) R. Br.	–	–	–	–	+	–	–	+
Epithema carnosum (G. Don) Benth.	–	–	–	–	+	–	–	–
Eragrostis gangetica (Roxb.) Steud.	+	+	–	–	+	–	–	–
Eragrostis tenella (Linn.) P. Beauv.	–	+	–	–	+	–	–	–
Eriochloa procera (Retz.) C. E. Hubb.	+	–	–	–	+	–	–	–
Eriocaulon truncatum Harm. *ex* Mart.	–	+	–	–	–	–	–	–
Eriocaulon quinquangulare Linn.	–	+	–	+	–	–	–	–
Fimbristylis bisumbellata (Forssk.) Bubani	–	+	–	–	+	–	–	+
Fimbristylis ovata (Burm. f.) Kern	–	–	–	–	+	–	–	+
Hoppea fastigiata (Griseb.) Clarke	–	+	–	–	–	–	–	–
Hydrilla verticillata (Linn. f.) Royle	–	–	–	–	–	+	+	+
Hydrolea zeylanica (Linn.) Sweet	–	+	–	–	–	–	–	–
Ipomoea cairica (Linn.) Sweet	–	+	–	–	–	–	–	–
Ipomoea pescaprae (Linn.) R. Br.	–	+	–	–	–	–	–	–
Isachne dispar Trin.	–	–	–	–	+	–	–	+
Lindernia antipoda (Linn.) Alston	–	+	+	–	+	–	–	+
Lindernia ciliata (Colsm.) Pennell	–	+	–	–	+	–	–	–
Lindernia crustacea (Linn.) F. Muell.	–	+	–	–	+	–	–	–
Lindernia pusilla (Willd.) Boldingh	–	+	–	–	–	–	–	–
Ludwigia octovalvis var. *sessiliflora* (Mich.) Raven	–	–	–	+	–	–	–	–
Ludwigia perennis Linn.	–	+	–	–	–	–	–	–
Mariscus compactus (Retz.) Druce	–	+	–	–	–	–	–	–

Name of the species	Habitat							
	S_1	S_2	S_3	S_4	S_5	P_1	P_2	M
Mariscus panicens (Rottb.) Vahl	–	+	–	–	–	–	–	–
Mariscus squarrosus (Linn.) Clarke	–	–	+	–	–	–	–	–
Murdannia dimorpha (Dalz.) Bruck.	–	+	–	–	–	–	–	–
Murdannia loriformis (Hassk.) Rolla Rao *et* Kammathy	–	+	–	–	–	–	–	–
Murdannia zeylanicum var. *longicapsa* (Clarke) Rolla Rao *et* Kammathy	–	–	–	–	+	–	–	–
Myriophyllum oliganthum (Wt. *et* Arn.) F. Muell.	–	–	–	–	–	+	–	+
Nymphaea pubescens Willd.	–	–	–	–	–	–	+	–
Oxalis corymbosa DC.	+	–	–	–	–	–	–	–
Paspalidium flavidum (Retz.) A. Camus	–	–	–	–	+	–	–	–
Paspalum conjugatum Berg.	+	–	–	–	–	–	–	–
Pedalium murex Linn.	–	+	–	–	–	–	–	–
Pistia stratiotes Linn.	–	–	–	–	–	+	–	–
Polygala javana DC.	–	–	+	–	–	–	–	–
Polygonum glabrum Willd.	–	–	+	–	–	+	–	+
Polypleurum stylosum (Wt.) J. B. Hill	+	–	–	–	–	–	–	–
Pouzolzia pentandra (Roxb.) Benn.	–	–	+	–	–	–	–	–
Pycreus globosus (All.) Reich.	–	–	–	–	+	–	–	+
Scirpus supinus Linn.	–	+	–	–	–	–	–	–
Setaria palmifolia (Koen.) Stapf	–	–	–	–	+	–	–	+
Sopubia delphinifolia (Roxb.) D. Don.	–	–	+	–	–	–	–	–
Sporobolus diander (Retz.) P. Beauv.	–	+	–	–	–	–	–	–
Utricularia graminifolia Vahl	–	+	–	+	–	–	–	–
Utricularia polygonoides Edgew.	–	–	+	–	–	–	–	–
Utricularia striatula Sm.	–	–	–	–	+	–	–	–
Xyris pauciflora Willd.	–	+	–	–	–	–	–	–

Phenology

An observation made during the present study of the hydrophytes of Courtallum is the relationship between climatic conditions and physiological functions like flowering. The relative abundance of different hydrophytic plants flowering in different months of the year has been analysed and the results are represented graphically (Fig. 2). A maximum number of aquatic plants in Courtallum flower during the months of September, October, November and December, i.e. towards the end or after the South-West monsoon. This agrees with the observation of Went (1957) that rain has a more profound influence in the flowering of tropical plants than any other factor. The increased diurnal temperature during the months following precipitation also enhance flowering. Thus a maximum number of hydrophytes in Courtallum flower in the month of November and in April it is the minimum, marking the 'true summer' for hydrophytes as rain ceases by January or February.

Discussion and conclusions

From the distribution of the various hydrophytes at Courtallum, it is evident that certain

species grow only in one habitat, i.e. pond, puddle or stream-bank at a particular place. This preference of habitat is mainly based on the ecological group the plant belongs and it forms the basis of those 'associations' recognised as characteristic of the type of vegetation. Thus several aquatic and amphibious 'associations' are recognised within the group 'hydrophytes' by different authors and each such 'association' is described to possess a characteristic floristic composition and is named after the dominant species forming it. But as understood from the studies of the hydrophytes at Courtallum, the concept of grouping plants into any such association is fallaceous. For no physiological relationship or similarity in structure or composition is exhibited by the members in such habitats and any of them can survive in a similar situation or 'ecological niche' with entirely different floristic components around. This is the reason why some plants are common to two or more so called 'associations' which itself shows the flexibility of the group.

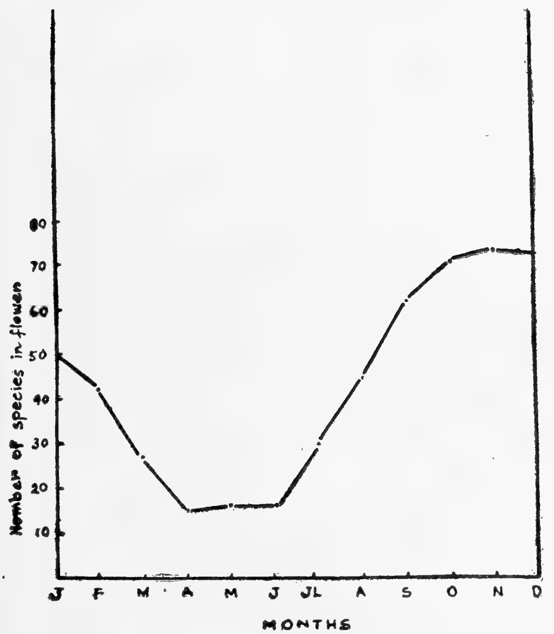


Fig. 2. Graph showing the number of hydrophytes flowering in each month of the year.

Although not strictly hydrophytic, the flora surrounding cascades and waterfalls as included in this group deserves special mention. The name 'water mountain plants' is proposed for the group by van Steenis (1965) and such plants find their natural habitat near waterfalls which has got a 'cool micro-climate' around it. The swiftly drifting flow usually keeps away from the rock surface for about 0.5 to 2 metres when it reaches the bottom, and the gap thus formed is peculiarly conditioned to lodge certain plants like *Utricularia striatula* Sm., *Epithema carnosum* (G. Don) Benth., species of *Impatiens* etc. some of which are sappy in nature. Due to the continuous spray of water from the falls, the rock surface is always wet and thus the vegetation on its face is distinctly zoned according to the availability of water. A maximum development of microclimate plants of this kind is at Swamiar falls and New falls. The species which grow in such habitats, complete their life-cycle within a month or two after the second monsoon, as the climate here gradually becomes more drier.

The occurrence of the species *Ipomoea pescaprae* (Linn.) R. Br. spreading in large areas along the deltas below the Main falls is significant in the vegetation type of Courtallum. Typically the species is found along sandy sea-shores and van Steenis (1965) while dealing with the beach formations of Java distinguished it as the 'pescaprae formation'. The plant is semiaquatic in Courtallum and the 'pescaprae formation' here helps to bind sand from being washed away in torrential monsoon flow. A characteristic nature of the plant is the presence of a spongy tissue inside the

stem with a hollow in the centre. As the deltas below Main falls are submersible in monsoon, the plants complete their life cycle by the onset of rainy season.

Summing up, the total number of hydrophytic plants recorded from Courtallum is about 76 angiosperm taxa as given in the table showing the relative distribution of each. From a conservation point of view the habitat and vegetation type of the area is quite significant for the presence of those characteristic species like *Epithema carnosum* (G. Don) Benth, *Polypleurum stylosum* (Wt.) J. B. Hill, *Ludwigia octovalvis* Raven subsp. *sessiliflora* (Mich.) Raven, *Canscora heteroclita* (Linn.) Gilg, *Didymocarpus innominatus* Burtt, etc. Such plants with special habitat requirements need protection by way of preserving their 'ecological niche', which otherwise is likely to get extinct soon. Those water mountain plants like *Utricularia striatula* Sm., *U. graminifolia* Vahl, *U. polygonoides* Edgew., *Impatiens* sp., *Epithema carnosum* (G. Don) Benth. etc. grow only in the 'micro-climate' around water falls and are very sensitive to slight changes in the environment. Courtallum being an important part of the monsoon land in the Western Ghats with several water falls and cascades can serve as an area for the preservation of those rare aquatics which require special humid habitats in a mountainous environment.

Acknowledgements

My sincere thanks to Dr. M. P. Nayar, formerly Keeper, Central National Herbarium, Botanical Survey of India, Howrah for his guidance during this study and to the Director, Botanical Survey of India for all facilities.

References

Arber, A. (1920): Water Plants. A study of aquatic Angiosperms. Cambridge.

Beadle, N. C. W. (1952): Ecological classification and nomenclature. *Proc. Linn. Soc. London (n.s.) 77*: 61-82.

Daubenmire, R. F. (1947): Plants and Environment (ed. 2, 1956). New York.

Fassett, N. C. (1940): A Manual of Aquatic Plants. New York & London.

Mirashi, M. V. (1957): Studies in the hydrophytes of Umred. *J. Indian Bot. Soc. 36*: 396-407.

Muenscher, W.C. (1944): Aquatic Plants of United States. New York.

Saxton, W. T. (1924): Phases of vegetation under monsoon conditions. *J. Ecol. 12*: 1-38.

Steenis, C. G. G. J. van (1965): In Backer, C.A. & R.C. Bakhuizen van den Brink, Flora of Java vol. 2 (Introductory part). Netherlands.

Subramanyam, K. (1962): Aquatic Angiosperms. *Bot. Mon. no. 3. C.S.I.R.* New Delhi.

———— & Nayar, M. P. (1974): Vegetation and Phytogeography of Western Ghats: in *Ecology and Biogeography in India.* (edited by M. S. Mani) pp. 178-196.

Thomas, K. J. (1962): A survey of the vegetation of Veli (Trivandrum) with special reference to ecological factors. *J. Indian Bot. Soc. 41*: 104-131.

Thronthwaites, C. W. & Hare, F. K. (1953): Climatic classification in forestry. *Unasylva 9*: 51-59.

Vyas, L. N. (1964): Vegetation of Alwar and its neighbourhood with the north-eastern Rajasthan vegetation. *J. Indian Bot. Soc. 43*: 322-333.

Weaver, J. E. & Clements F. E. (1929): Plant Ecology (ed. 2, 1938). New York & London.

Went, F. W. (1957): The experimental Control of Plant Growth. Waltham Mass.

EXPERIMENTAL STUDIES ON VISION IN INDIAN SNAKES[1]

HOLGER RUMPFF[2]

(*With a text-figure*)

In about 300 specimens of 10 species of Indian snakes, the visual acuity was tested by optomotor reactions. 6 species yielded results ranging from 4′30″ (angular degrees) in the ratsnake (*Ptyas mucosus*) to 1°15′ in the dog-faced watersnake (*Cerberus rhynchops*). An intermediate visual acuity is represented by the saw-scaled viper (*Echis carinatus*), with 12 angular minutes reaching the visual acuity of the European lizard *Lacerta agilis*. On the contrary, the Cobra (*Naja naja*) with 5′30″ has a definitely better vision than the lizard. Surprisingly, the Indian Python did not show any optomotor reactions at all.

Vision can be assessed by studying brightness discrimination and colour perception or by quantifying the visual acuity. The latter is the most important factor determining the quality of visual information of an individual. Moreover, visual acuity is a favourable means of comparing 'vision' in various animal species, and, of course, in man.

Visual acuity can be determined by at least three methods: i. by histological measurements, i.e. assessing the angle between the optical axes of two neighbouring retinal elements; ii. by using optomotor reactions of the experimental animal in a revolving black-white striped drum; iii. by classical conditioning, i.e. making the animal respond to one of two black-white striped visual discriminanda.

The data obtained by method i. are referred to as morphological visual acuity, while methods ii. and iii. would yield the physiological visual acuity. These methods will be dealt with in more detail later on. For a survey of findings on the visual acuity in mammals and birds is presented in the Table 1.

Unfortunately, and in contrast to the list in Table 1, corresponding studies in reptiles, amphibians and fishes are scanty. This can be seen from Table 2.

It must be mentioned here, that the term 'minimum separabile' denotes the narrowest black-white striped pattern resolved by the test animal in the optomotor or conditioning situation.

Visual acuity is limited by various factors, of which the following are most important: It is obvious, that vision in its broadest sense is determined by the structure of the retina, i.e., the diameter of retinal receptors and their spatial density (as number per square unit). Apart from this geometrical aspect, visual acuity is also affected by the number of receptors per ganglionic cell. Obviously, this ratio is at best 1:1, which means, that each visual receptor has its own separate ganglionic connection to the brain (Walls 1942).

Such favourable ratios are only found in the area centralis, and hence, here visual performance is optimal. Towards the periphery of the retina this ratio is definitely inferior, here many

[1] Accepted December 1978.

[2] Physiology and Ecology Department, Faculty of Biology, Münster University, Germany.

TABLE 1

VISUAL ACUITY IN MAMMALS AND BIRDS

Species	Visual acuity	Author
man	20″	Loevenich 1949
chimpanzee	28″	Spence 1934
Indian elephant	10′20″	Altevogt 1955
dwarfgoat	9′36″	Backhaus 1959
donkey	8′36″	Backhaus 1959
cat	5′30″	Smith 1936
bats	5°–3°	Suthers 1966
deermice	1°34′–33′	Rahmann *et al.* 1968
chinchilla	30′	Thomas 1964
Indian vulture	13′3″	Fischer 1969
white scavenger vulture	13′3″	Fischer 1969
budgerigar	28″	Kurze 1976
blackbird	1′20″	Donner 1951
robin	2′38″	Donner 1951
yellow bunting	3′07″	Donner 1951

TABLE 2

Species	Visual acuity as minimum separabile	Author
minnow	11′	Brunner 1935
cichlid fish	5′30″	Baerends and coworkers 1960
common carp	16′	Zimmer 1966
frog	6′53″	Birukow 1938
lizard	11′28″	Ehrenhardt 1937
tortoise	5′30″	Dudziak 1956

receptor cells are switched to only one ganglionic pathway. Not all animal eyes studied attain the 1:1 ratio.

For geometrical reasons, the quality of the retinal image is also determined by shape and size of the lens. Clearly, accommodation comes about by altering focal length. From geometrical considerations it becomes clear, that the retinal image depends also on the size of the eye, and generally, a larger eye is more efficient than a smaller one (Von Buddenbrock 1952). This was found in man, where the average adult visual acuity according to Spence (1934) amounts to 26″ while in

Infants it averages only 37″.

A similar finding by Baerends and coworkers (1960) refers to adult and juvenile fishes (*Aequidens portalegrensis*): 10-11 cm long adults averaged 5′-30′, youngsters scored only 44′32″.

From personal experience everybody knows that visual acuity strongly depends on environmental brightness. Apart from this well-known fact in humans this has been shown in a number of animals also (see: Brunner 1935, Ehrenhardt 1937, Birukow 1938, Donner 1951, Altevogt 1955, Kurze 1976, and others).

Corresponding to retinal brightness the size of receptive retinal areas varies and is smallest at optimal brightness level. Under such conditions the 1:1 ratio of retinal and ganglionic elements is obtained, and visual performance is best (Kuffler 1952, Kuffler and coworkers 1957, and Granit 1955 and 1957).

As mentioned above, visual acuity can also be quantified by methods of classical conditioning, i.e. training the test animal to choose the finer striped pattern versus the coarse striped one.

Apart from the experimental methods mentioned, one can also obtain information on the visual acuity of an animal by observations in the field. Thus, one can calculate the visual acuity from the distance from which a prey of a certain size (say a mouse) is spotted by an animal (say a bustard). In this manner Schuyl and Tinbergen (1936) measured the visual acuity of the Peregrine falcon (*Falco subbuteo*) as 21″ (from Fischer 1969). Similarly, Ehrenhardt (1937) offered a mealworm at a distance of 95 cm from a lizard (*Lacerta vivipara*) and saw, that the test animal spotted the prey from this distance guided exclusively by visual clues. The visual acuity under these conditions amounted to 14′38″.

The conditioning method mentioned above can successfully be applied only in animals of sufficient learning capacity. According to common belief, snakes do not seem to be gifted learners, so that classical conditioning seems unfeasible.

Therefore I turned to using optomotor reactions by placing the test animal in the centre of a revolving drum featuring vertical aequidistant black-white stripes, the dimensions of which could be varied. The animal reflectorily tries to keep its visual field constant by following the moving stripes with eyes, head or body movements. These efforts result in jerkwise movements in correlation with rotation speed, and size and number of black and white stripes. From Ehrenhardt's studies (1937) we have the first records of visual acuity in the European lizard species *Lacerta agilis* (Table 2).

From the above remarks and facts mentioned, it seems appropriate that for the determination of visual acuity in snakes the optomotor method should be applied. In captivity, snakes are rather delicate animals, sometimes refusing food for weeks and months. Optomotor reactions, however, remain independent of rearing conditions. Thus, they yield reliable data. Thanks to the favourable opportunities offered by the Madras Snake Park and my laboratory facilities in the Zoological Institute in Münster University I could work on about 300 Indian snakes belonging to 10 species.

In the Madras Snake Park the animals lived under nearly natural habitats though under slightly crowded conditions. They were given frogs and mice in sufficient numbers. In the Münster laboratory, the animals were housed in large terraria at temperatures between 25° C and 28° C, the relative humidity ranging from 40 to 70%. Baby mice and frogs were given as food.

The optomotor apparatus is shown in fig. 1 from which also the relevant dimensions can be seen. The revolving drum was first equipped with vertical stripes of 35 cm, equalling 20 angular degrees. If this pattern evoked optomotor reactions in the test animal, I would reduce the width of the stripes by half, i.e. to 17.5 cm, equalling 10°. By further reducing the width I was able to provide visual angles of 5°, 2.5°, 1°15′, 17′, 5′57″. As it proved difficult to precisely cut black paper stripes of less than 5 mm width, equalling 17′, I finally used precisely striped cloth, the dark brown and white stripes being 1.73 mm wide each, equalling 5′57″.

(iii) eye movements only.

The number of such eye movements per time unit was noted down and proved to be nearly constant in each species under given conditions.

The revolving speed of the striped patterns must not exceed a certain angular velocity to make sure that true optomotor reactions can occur. Above that critical velocity, single visual events (i.e. stripes) cannot properly be separated and tend to blur resulting in a sort of flicker-fusion frequency effect. As stated above, visual acuity is affected by illumination level also. Brightness in my experiments in Madras ranged from 300 to 4,800 Lux and from 20

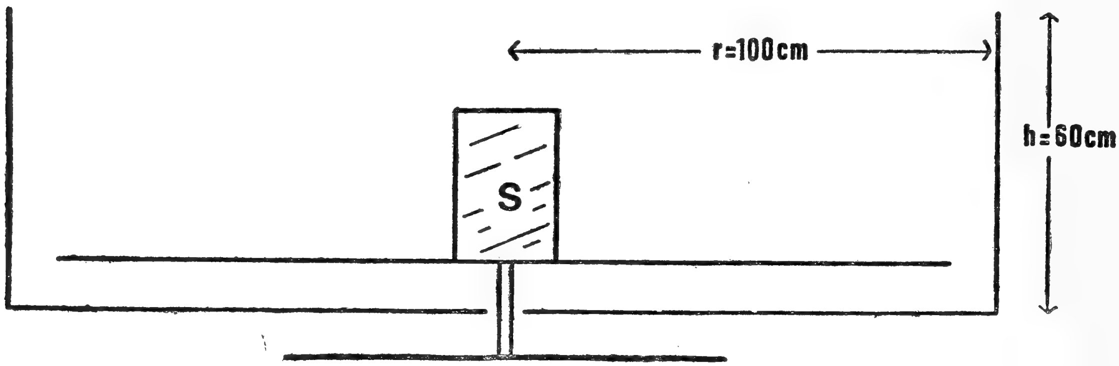


Fig. 1. Optomotor apparatus with rotating drum and fixed stand. S = snake in glass cage.

Back home I could obtain black-white paper stripes of 2 mm (=12′10″), 1 mm (=6′05″), and 0.5 mm (=3′03″). Intermediate angular presentations were realised by shifting the normally central position of the test animals' glass cage towards the periphery of the revolving drum, i.e. closer to the striped pattern. The reactions of the test animal consisted in:

(i) moving the whole body in the same direction as the revolving drum,

(ii) moving its anterior body portion or its head only,

to 150 Lux in Münster, and there was no noticeable influence of illumination levels in this range on the visual acuity.

Of the 10 species tested in this manner, 6 yielded quantitative data, a survey of which is presented in the Table 3.

It may be mentioned that the behaviour of *Amphiesma stolata* was especially suited for the experimental procedure as their reactions were prompt and easily discernible. On the other hand, the rat snake (*Ptyas mucosus*) proved much less readily adapted to the experi-

TABLE 3

VISUAL ACUITY OF THE TESTED SPECIES

Ptyas mucosus (Rat snake):	4′30″
Amphiesma stolata (Striped keel-back):	<6′
Xenochrophis piscator (Checkered keel-back):	20′–40′
Cerberus rhynchops (Dog-faced water snake):	<1°15′
Naja naja (Cobra):	5′30″
Echis carinatus (Saw-scaled viper):	12′

mental situation. This may also account for the fact, that occasionally the test animal would not directly respond to the moving stripes but only in a delayed reaction. Working with cobras, though they were rather difficult to handle, proved a sheer pleasure at the broad stripes: placed in their central observation glass house, they would immediately lift their hood and precisely follow the moving striped pattern. Hence, the recorded data were especially reliable and easy to interpret. In contrast, the optomotor reactions of the saw-scaled viper (*Echis carinatus*) were difficult to observe. This was due to their small body size and minute optomotor eye movements.

Apart from the species listed above, a number of other Indian snake species did not show any optomotor reactions at all. Even if offered very coarse corresponding to 10° and 20°, they did not react. The unsuccessfully tested species were the following:

Elaphe helena: 4
Dendrelaphis tristis: 8
Ahaetulla nasutus: 8
Python molurus: 1

The results obtained above should be viewed in comparison to vision in other animals, e.g. the saw-scaled viper's visual acuity equals that of the European lizard (*Lacerta agilis*), both attaining 12′. It is remarkable that this seminocturnal viper's visual acuity reaches the level of the truly diurnal lizard.

Cobras (5.5′) and rat snakes (4.5′) are endowed with a definitely better vision than the lizard mentioned, and in this respect they compare almost with song birds like blackbird and yellow bunting.

ACKNOWLEDGEMENTS

I am grateful to Prof. Dr. R. Altevogt for suggesting the topic and for guidance. Thanks are also due to the Akademisches Auslandsamt of Münster University (Dr. Wilske) for financial assistance and to R. Whitaker, Director of the Madras Snake Park, and his wife for their ever ready cooperation and warm hospitality.

REFERENCES

ALTEVOGT, R. (1955): Das visuelle Minimum separabile eines Indischen Elefanten. *Z. vergl. Physiol. 37*: 325-337.

BACKHAUS, D. (1959): Experimentelle Untersuchungen über die Sehschärfe und das Farbsehen einiger Huftiere. *Z. Tierpsych. 16*: 445-467.

BAERENDS, G. B., BENNEMA, B. E., AND VOGELZANG, A. A. (1960): Uber die Anderung der Sehschärfe mit dem Wachstum bei *Acquidens portalegrensis. Zool. Jb. Syst. 88*: 67-78.

BIRUKOW, G. (1938): Untersuchungen über den optischen Drehnystagmus und über die Sehschärfe des Grasfrosches (*Rana temporaria*) *Z. vergl. Physiol. 25*: 92-142.

BRUNNER, G. (1935): Uber die Sehschärfe der Elritze (*Phoxinus laevis*) bei verschiedenen Helligkeiten. *Z. vergl. Physiol. 21*: 296-316.

BUDDENBROCK, W. VON (1952): Grundriss der vergleichenden Physiologie. I.: Physiologie der Sinnesorgane und des Nervensystems. Berlin.

DONNER, K. O. (1951): The visual acuity of some passerine birds. *Acta Zool. Fenn. 66*: 3-40.

DUDZIAK, J. (1956): Visual acuity in the *Emys orbicularis* L. tortoise in air and water. *Fol. biol. 3*: 203-228.

EHRENHARDT, H. (1937): Formensehen und Sehschärfebestimmungen bei Eidechsen. *Z. vergl. Physiol. 24*: 248-304.

FISCHER, A. B. (1969): Laboruntersuchungen und Freilandbeobachtungen zum Sehvermögen und Verhalten von Altweltgeiern. *Zool. Jb. Syst. 96*: 81-132.

GRANIT, R. (1955): Receptors and sensory perception. New Haven.

———— (1957): Einige Ergebnisse und Prinzipien der Netzhautforschung. *Studium gen. 10*: 244-251.

KUFFLER, S. W. (1952): Neurons in the retina: Organization, inhibition, and excitation problems. *Cold Spring Harbor Sympos. Quant. Biol. 17*: 281-292.

KUFFLER, S. W., FRITZHUGH, R. AND BARLOW, H. B. (1957): Maintained activity in the cat's retina in light and darkness. *J. gen. Physiol. 40*: 683-702.

KURZE, M. (1976): Sehschärfe und Umfeldhelligkeit beim Wellensittich. Staats. Zool. Inst. Münster.

LOEVENICH, H. K. (1949): Untersuchungen über das foveale und parafoveale Auflösungsvermogen. *Pflügers Arch. ges. Physiol. 252*: 17-29.

RAHMANN, H., RAHMANN, M. AND KING, J. A. (1968): Comparative visual acuity (Minimum separabile) in five species and subspecies of deermice (*Peromyscus*). *Physiol. Zool. 41*: 298-312.

SCHUYL, G. AND TINBERGEN, N. (1936): Ethologische Beobachtungen an Baumfalken (*Falco s. subbuteo*). *J. Ornith. 84*: 387-434.

SMITH, K. U. (1936): Visual discrimination in the cat: IV. Visual acuity of the cat in relation to stimulus distance. *J. gen. Physiol. 49*: 125-138.

SPENCE, K. W. (1934): Visual acuity and its relation to brightness in chimpanzee and man. *J. comp. Psychol. 18*: 333-361.

SUTHERS, R. A. (1966): Optomotor responses by echolocating bats. *Science 152*: 1102-1104.

THOMAS, N. (1964): Räumliches Sehen und Sehschärfe bei Wirbeltieren. Staats. Zool. Inst. Münster.

WALLS, G. L. (1942): The vertebrate eye and its adaptive radiation. Bloomfield Hills.

ZIMMER, H. (1966): Der Lichtsinn der Fische, mit besonderer Berücksichtigung der Sehschärfe. Staats. Zool. Inst. Münster.

A CATALOGUE OF THE INDIAN SIGNIPHORIDAE (INSECTA: HYMENOPTERA: CHALCIDOIDEA)[1]

MOHAMMAD HAYAT AND MAHESH VERMA[2]

INTRODUCTION

Since the publication of the 'Catalogue of Indian Insects pt. 23 Chalcidoidea' by Mani (1938), the knowledge on the taxonomy of Indian chalcid flies has increased considerably. Many genera and several hundred species have been added to the chalcid fauna of India. Consequently, that catalogue has become very much out of date, and the need is felt for more recent catalogues on this superfamily. The present catalogue to one of the important families (Signiphoridae) is an attempt in this direction.

The Signiphoridae is a small family of the chalcidoid Hymenoptera containing only seven genera. Members of this family are hyperparasites, attacking other primary parasites of harmful insects and so are considered harmful.

A detailed review of the family is not given here. For this Rosanov (1965) and De Santis (1968) and other papers given under 'References' should be consulted. Presently the following genera are recognised in this family: *Chartocerus* Motschulsky; *Thysanus* Walker; *Signiphora* Ashmead; *Clytina* Erdös; *Neosigniphora* Rust (synonym of *Thysanus* in Rosanov, 1965; but valid in De Santis, 1968); *Kerrichiella* Rosanov, and *Rozanoviella* Subba Rao. In *Chartocerus*, Rosanov recognised three subgenera: *Chartocerus* s. str., *Xana* Kurdjumov, and *Signiphorina* Nikol'skaya. Subba Rao (1974) has shown that Rosanov's treatment of *Matritia* as a synonym of *Xana* was incorrect since *Matritia* is the earlier published name.

Scope: The present catalogue is restricted to the Indian species of the Signiphoridae. Nevertheless several extralimital (non-Indian) records have been included when these give much needed information on synonymy, distribution, hosts, etc.

Type depositories: Type depositories are indicated in the catalogue using the abbreviations explained below:

- BMNH British Museum (Natural History), London.
- NPCI National Pusa Collection, Indian Agricultural Research Institute, New Delhi.
- ZIASL Zoological Institute, Academy of Sciences, Leningrad.
- ZMAMU Zoology Department, Aligarh Muslim University, Aligarh.
- ZMMS Zoological Museum, Moscow State University, Moscow.
- ZSI National Collections, Zoological Survey of India, Calcutta.

Abbreviations: The following abbreviations are used in the catalogue

- des. Description, but not original description.
- distrib. Distribution.
- fig. Figure or figures.
- o.d. Original description.

[1] Accepted August 1978.

[2] Department of Zoology, Aligarh Muslim University, Aligarh, India.

preocc. Pre-occupied, used after bibliographic citation to indicate a homonym.
tax. Taxonomy.

SIGNIPHORIDAE

Selected bibliography: Howard, 1894, *Insect Life* 6: 234 (Signiphorinae); Ashmead, 1900, *Proc. U.S. natn. Mus.* 22: 323-24, 409-12 (Signiphorinae, subfamily of Encyrtidae); Girault, 1913, *Proc. U.S. natn. Mus.* 45: 189-233 (Signiphorinae, revision of nearctic species); Girault, 1915, *Mem. Qd. Mus.* 4: 67-72 (Signiphorinae, subfamily of Encyrtidae; Australian spp.); *Mercet, 1916, *Boln. r. Soc. esp. Hist. nat.* 16: 519-523 (Signiphorinae, Spanish spp.); *Silvestri, 1918, *Boll. Lab. Zool. Gen. agr. Portici* 12: 266-271; Nikol'skaya, 1950, *Dokl. Akad. nauk. SSSR* 75: 319-321 (Signiphoridae, Key to genera, taxonomy); Peck in Muesebeck *et al.*, 1951, *U.S.D. A.Ag. mong.* 2: 472 (Thysanidae, nearctic catalogue); Nikol'skaya, 1952, *Opred faune SSSR* No. 44: 502-509 (Signiphoridae, key to genera, USSR species); Ferriére, 1953, *Mitt. Schweiz. ent. Ges.* 26: 4-5, 39 (Signiphorinae, subfamily of Encyrtidae; Key to genera); Kerrich, 1953, *Bull. ent. Res.* 44: 789-810 (Thysanidae, taxonomy); Peck, 1963, *Can. Ent. Suppl.* 30: 324-330 (Signiphoridae, nearctic catalogue); Boucek in Peck, Boucek and Hoffer, 1964, *Mem. ent. Soc. Canad.* 34: 11, 90-91 (Thysanidae, Key to genera); Erdös, 1964, *Fauna Hung.* No. 73: 320-327 (Thysanidae = Signiphoridae, Key to genera; Hungarian spp.); Rosanov, 1965, *Ent. Obozr.* 44: 866-884/English translation: *Ent. Rev.* 44: 508-516/(Signiphoridae, Key to genera, subgenera; taxonomy; synonymy; list of species; distribution; hosts); De Santis, 1968, *Revta fac. Agron. La Plata* 44: 7-16 (Signiphoridae, subfamilies Signiphorinae and Thysaninae; key to genera; taxonomy; synonymy; list of species); Hayat, 1970 *Entomophaga,* 15: 387-399 (Signiphoridae, key to genera, Indian species); Subba Rao, 1974, *Bull. ent. Res.* 64: 525-531 (Signiphoridae, key to genera; taxonomy.)

*Original not seen.

Genus **Chartocerus** Motschulsky

Chartocerus Motschulsky; 1859, *Etude Ent.* 8: 171. Type species: *Chartocerus musciformis* Motschulsky; monobasic *Matritia* Mercet, 1916 *Boln. r. Soc. esp. Hist. nat.* 16: 523-525. Type species: *Signiphora (Matritia) conjugalis* Mercet; monobasic, original designation.

Xana Kurdjumov, 1917, *J. appl. Ent.* 1: 80-81. Type species: (*Xana nigra* Kurdjumov) = *Xana kurdjumovi* Nikol'skaya, 1950; monobasic, original designation.

Signiphorina Nikol'skaya, 1950, *Dokl. Akad. nauk. SSSR.* 75: 319-21. Type species: *Neosigniphora elongata* Girault; original designation.

Subgenus *Chartocerus* s. str.

1. **C. (C.) musciformis** Motschulsky

Chartocerus musciformis Motschulsky, 1859, *Etude, Ent.* 8: 171, ♀, o.d., (Nura Ellia, Sri Lanka; type ZMMS), host a; Cotes, 1893, *Indian Mus. Notes* 2(6): 155; Barlow, 1900, *Indian Mus. Notes.* 4(4): 219, host a; Ayyar, 1925, *Spolia Zeylon.* 13: 252, catalog; Mani, 1938. *Cat. Indian Ins.* pt. 23: 153; Rosanov, 1969, *Ent. Obozr.* 48: 340-342, ♀, des., type examined, fig., host a.

Chartocerus (Chartocerus) musciformis: Rosanov, 1965, *Ent. Rev.* 44: 511-513, tax. distrib.; De Santis, 1968, *Revta fac. Agron.* 44: 12.

Host: Pseudococcidae: (a) *Pseudococcus* sp. on Coffee (*Coffeae* or *Adonidum*). True host is probably the encyrtid, *Microterys nietneri* which is found to parasitise this pseudococcid.

Distribution: Sri Lanka, Nura Ellia.

[This species is very closely related to *C. walkeri* Hayat, and the latter may prove to be a synonym of Motschulsky's species. Pending comparison of the respective types, *walkeri* is treated as valid, and for this reason *musciformis,* though not yet recorded from India, is included in the present catalogue.]

2. **C. (C.) walkeri** Hayat

Chartocerus (Xana) walkeri Hayat, 1970, *Entomophaga* 15: 393, ♀, o.d., fig., key, (Aligarh, India; type ZSI, paratypes, ZSI, ZIASL, ZMAMU, Hayat colln.), also Joginder Nagar, host b.

[This species was erroneously placed in the subgenus *Xana* by Hayat (1970) whereas it belongs to the subgenus *Chartocerus* as is con-

firmed by the study of males (See below). Apart from the character pertaining to the female antennae, the male genitalia are characterised by the presence of papilliform processes on the phallobase distally.]

Further material examined: INDIA: Himachal Pradesh, Joginder Nagar, 27.VI.1967, 5 ♂♂, ex *Rastrococcus iceryoides* Green on *Zizyphus* sp.; Uttar Pradesh, Aligarh, 25.XII.1968. 1♂, ex *Diaphorina cardiae* Crawford; 26.IX.1970, 1 ♂, ex Coccid (all M. Hayat). 1 ♂ deposited in ZIASL.

Hosts: Psyllidae: (a) *Diaphorina cardiae* Crafd.; Pseudococcidae: (b) *Rastrococcus iceryoides* (Green)

Distribution: INDIA: Himachal Pradesh, Uttar Pradesh.

Subgenus *Matritia* Mercet

3. **C. (M.) hyalipennis** Hayat

Chartocerus (*Xana*) *hyalipennis* Hayat, 1970, *Entomophaga* 15: 391-392, ♀, ♂, o.d., fig., key, (Shencottah, India; type ZSI, paratypes, ZSI, ZMAMU; Hayat colln.), also Madurai, Karunagapally, Kalamasseri, Shoranur, Hissar, Dindigul; hosts a-c.

Hosts: Pseudococcidae: (a) *Centrococcus insolitus* (Green); (b) *Nipaecoccus* sp.; (c) *N. viridis* (Newstd.).

Distribution: INDIA: Haryana, Kerala, Tamil Nadu.

4. **C. (M.) kerrichi** (Agarwal)

Matritia kerrichi Agarwal, 1963, *Z. Parasitkde.* 22: 390-393 ♀, o.d., fig., key (Aligarh, India; types ZMAMU), host, f.

Chartocerus (*Xana*) *kerrichi*: Rosanov, 1965, *Ent. Rev.* 44: 513; De Santis, 1968, *Revta. fac. Agron. La Plata,* 44: 12; Hayat, 1970, *Entomophaga* 15: 391, 394-395, ♀, ♂, des., fig., key, Aligarh, Ponnur, Kancheepuram, Ranipet, Avadi, Villupuram, Madurai, Tenkasi, Shoranur, Hubli, Srirangam, Joginder Nagar; hosts, a-e, g, h.

Chartocerus (*Matritia*) *kerrichi*: Hayat, 1976, *Orient. Ins.* 10: 161, ♀, ♂, distrib., hosts, Srirangam.

Hosts: Asterolecaniidae: (a) *Cerococcus* sp. on *Hibiscus rosasinensis;* Pseudococcidae: (b) *Centrococcus insolitus* (Green), (c) *Nipaecoccus* sp. on *Casuarina equisetifolia,* (b) *N. viridis* (Newstd.), (e) *Rastrococcus* sp.; Dactylopiidae: (f) *Eriococcus greeni* Newstd.; Miscellaneous coccoids: (g) coccids on *Citrus limonum,* (h) coccids on *Saccharum officinarum.*

Distribution: INDIA: Andhra Pradesh, Himachal Pradesh, Karnataka, Kerala, Tamil Nadu, Uttar Pradesh.

5. **C. (M.) kurdjumovi** (Nikol'skaya)

Xana nigra Kurdjumov, 1917, *J. appl. Ent.* 1: 80-81, ♀, ♂, o.d., fig., (Poltova, Crimea, USSR; Types ZIASL), hosts, *Eriococcus greeni* Newstd., puparia of *Leucopis* sp.? (preocc. by *Signiphora nigra* Ashmead, 1900).

Xana kurdjumovi Nikol'skaya, 1950, *Dokl. Akad. SSSR.* 75: 320, fig., key hosts, U.S.S.R. distrib.: (replacement name for *Xana nigra* Kurdjumov); Nikol'skaya, 1952, *Opred. faune SSSR.* No. 44: 507, key, hosts, U.S.S.R. distrib.; Erdos, 1958, *Folia ent. hund.* 11: 75, Hungary; Erdös, 1964, *Fauna Hung.* No. 73: 325-326, fig., key, Hungary.

Matritia kurdjumovi: Agarwal, 1963, *Z. Parasitkde.* 22: 389, key.

Chartocerus (*Xana*) *kurdjumovi*: Rosanov, 1965, *Ent. Rev.* 44: 512-513, fig., tax., distrib., hosts; De Santis, 1968, *Revta fac. Agron La Plata* 44: 12; Hayat, 1970, *Entomophaga* 15: 391, 394, ♀, fig., key, Aligarh, Patiala, Salem, Tuticorin; hosts, a, c, d.

Chartocerus (*Matritia*) *kurdjumovi*: Hayat, 1976, *Orient. Ins.* 10: 162, ♀, Indian distrib., hosts, Tuticorin; host b.

Hosts: Pseudococcidae: (a) *Centrococcus insolitus* (Green), (b) *Nipaecoccus viridis* (Newstd.), (c) *Nipaecoccus* sp. on *Acacia* sp. and *Hemigraphes* sp., (d) *Rastrococcus iceryoides* (Green).

Distribution: INDIA: Punjab, Tamil Nadu, Uttar Pradesh.

Subgenus *Signiphorina* Nikol'skaya

6. **C. (S.) fimbriae** Hayat

Chartocerus (*Signiphorina*) *fimbriae* Hayat, 1970, *Entomophaga* 15: 396-398, ♀, ♂, o.d. fig., (Tenkasi, India; type ZSI, paratypes, ZSI, ZMAMU, Hayat colln.), also Tuticorin, hosts, a,b.; Hayat,

1976, *Orient. Ins.* 10: 162, fig., distrib., hosts.

Hosts: Coccidae: (a) *Ceroplastodes cajani* (Maskell), Pseudococcidae: (b) *Nipaecoccus viridis* (Newstd.).

Distribution: INDIA: Tamil Nadu.

7. **C. (S.) intermedius** Hayat

Chartocerus (*Signiphorina*) *intermedius* Hayat, 1976, *Orient. Ins.* 10: 162-163, ♀, ♂, o.d., fig., (Bareilly, India; type ZSI, paratypes, ZSI), host, a.

Host: Pseudococcidae: (a) mealybug.

Distribution: INDIA: Uttar Pradesh.

8. **C. (S.) ranae** (Subba Rao)

Thysanus ranae Subba Rao, 1957, *Proc. Indian Acad. Sci.* B. 46: 388-390, ♀, ♂, o.d., fig., (New Delhi, India; types NPCI), host, a.

Matritia ranae: Agarwal, 1963, *Z. Parasitkde.* 22: 389-390, key, tax.

Chartocerus (*Xana*) *ranae* Rosanov, 1965, *Ent. Rev.* 44: 513; De Santis, 1968, *Revta. fac. Agron. La Plata* 44: 12; Hayat; 1970, *Entomophaga* 15: 387, 391, key.

Host: Pseudococcidae: (a) *Saccharicoccus sacchari* Coq. *Distribution*: INDIA: New Delhi.

[This species was placed in the subgenus *Xana* by Rosanov (1965) and Hayat (1970) but it is best placed in the subgenus *Signiphorina* as the length of the marginal fringe of fore wings according to the original description and figure, is more than one-half the width of the wing.]

Genus **Thysanus** Walker

Thysanus Walker, 1840, *Ann. nat. Hist.* 4: 234; type species: *Thysanus ater* (Haliday) Walker; monobasic.

Triphasius Foerster, 1856, *Hym. Stud. Heft.* 2: 83, 84; Type species: *Thysanus ater* Walker; autobasic (Proposed as a replacement name for *Thysanus* Walker, preocc. (!) by *Thysanus* in Botany.

Plastocharis Foerster, 1856, *Hym. Stud. Heft.* 2: 145; Type species: *Thysanus ater* Walker; autobasic (Proposed to replace *Triphasius* preocc. (!) by *Triphasia* in Botany).

9. **T. ater** (Haliday) Walker

[The literature on this species is very extensive, so only relevant references are cited below.]

Thysanus ater Walker, 1840, *Ann. nat. Hist.* 4: 234, ♀, ♂, o.d. fig., (England; Types BMNH); Walker, 1841, *Entomologist,* Tab. K. fig. 3 (♂); Walker, 1873, *Entomologist* 6: 473, fig.; Dalla Torre, 1898, *Cat. Hym.* 5: 223, catalog.; Mercet, 1912, *Trab. Mus. nac. Cienc. nat.* 10: 124, des., fig.; Nikol'skaya, 1950, *Dokl. Akad. nauk. SSSR.* 75: 319-321, fig.; distrib., host, U.S.S.R.; Kerrich, 1953, *Bull. ent. Res.* 44: 806-808, tax.; Erdös, 1958, *Folia ent. hung.* 11: 75, Hungary; Szezepanski, 1961, *Sylwan,* 3: 39-40, hosts, Poland; Erdos, 1964, *Fauna hung.* No. 73: 322-323, fig., distrib., Hungary; Rosanov, 1965, *Rev. Ent.* 44: 510, fig., tax., distrib.; De Santis, 1968, *Revta fac. Agron. La Plata* 44: 11, tax.; Hayat, 1970, *Entomophaga* 15: 388-390, ♀, des., fig., Aligarh, host, a.

Host: Coccidae: (a) *Pulvinaria maxima* Green.

Distribution: INDIA: Uttar Pradesh.

Thysanus spp. [All the following records most probably refer to species of *Chartocerus*]

(i) *Thysanus* sp.: Abbasi and Singh, 1966, *Indian J. Ent.* 28: 408-410, Delhi, host *N. viridis.*

(ii) *Thysanus* sp.: Singh and Abbasi, 1966, *Indian J. Ent.* 28: 413-414. Delhi, host *Cerococcus hibisci* Green.

(iii) *Thysanus* sp.: Subba Rao *et al.*: 1965, *Indian J. Ent.* 27: 109-110, Delhi, host *Nipaecoccus viridis.*

(iv) *Thysanus* sp. near *elongatus* (Girault): Usman and Puttarudriah, 1955, *Dept. agric. Mysore State ent. Bull.* No. 16: 130, Mandya, host mealybug.

Acknowledgements

We are thankful to Prof. S. Mashhood Alam, Head of the Department of Zoology, Aligarh Muslim University, Aligarh, for providing pecessary facilities. One of us (Mahesh Verma) is thankful to the U.G.C. for financial assistance.

References

Only some of the important works on the family Signiphoridae are listed below. The list is neither exhaustive nor it is intended to be so.

AGARWAL, M. M. (1963): *Matritia kerrichi*, n. sp. (Hymenoptera: Thysanidae) an endoparasite of *Eriococcus greeni* Newst, recorded from Aligarh (India). *Z. Parasikkde. 22*: 389-393.

ASHMEAD, W. H. (1900): On the genera of the Chalcid-flies belonging to the sub-family Encyrtinae. *Proc. U.S. natn. Mus. 22*: 324, 409-312.

ASHMEAD, W. H. (1904): Classification of Chalcid-flies of the super family Chalcidoidea. *Mem. Carnegie Mus., 1*: 311, 497.

DE SANTIS, L. (1968): Nomenclatural classification de la familia Signiphoridae (Hymenoptera; Chalcidoidea). *Revista fac. Agron. La Plata 44* 7-16.

DOMENICHINI, G. (1955): Variabilita dei Carat teri e nuova diagnosi de un Tisanide (Hymenoptera: Chalcidoidea) con la descrizione di una nuova specie. *Boll. Zool. Agric. Bachic. 21*: 2-20.

ERDOS, J. (1964): Fauna Hungariae, 12 (Hymenoptera 11, Chalcidoidea III): 320-327.

FERRIERE, Ch. (1953): Encyrtides palearctiques (Hymenoptera: Chalcidoidea) Nouvelle table des generes avec notes et synonymies. *Mitt. Schweiz. ent. Ges., 26*: 1-45.

GIRAULT, A. A. (1913): A systematic monograph of the Chalcidoid Hymenoptera of the subfamily Signiphorinae. *Proc. U.S. nat. Mus., 45*: 189-233.

HAYAT, M. (1970): Studies on the genera of the family Signiphoridae (Hymenoptera: Chalcidoidea) recorded from India. *Entomophaga 15*: 387-399.

HAYAT, M. (1976): Some Indian Species of *Chartocerus* (Hymenoptera: Chalcidoidea: Signiphoridae), *Orient. Insects 10*(2): 161-164.

HOWARD, L. O. (1894): The Hymenopterous parasites of the California red scale. *Insect Life, 6*: 233-235.

KERRICH, G. J. (1953): Report on the Encyrtidae associated with mealybugs on Cacao in Trinidad and on some other species related thereto. *Bull. ent. Res., 44*: 802-810.

KURDJUMOV, N. V. (1917): New genus and species of Aphelininae (Chalcidoidea). *J. Appl. Ent. 1*: 80-81.

MERCET, R. G. (1916): Signiforinos de Espana (Himenopteros: Chalcididos). *Boln. R. Soc. esp. Hist. nat. 16*: 519-533.

NIKOL'SKAYA, M. N. (1950): Representatives of the family Signiphoridae (Hymenoptera: Chalcidoidea) in the fauna of the USSR. *Akad. Nauk. SSSR. 75*: 319-321. (In Russian).

NOVICKYS/NOVITZKY, NOVICKY, S. (1954): Sinonimia e destribuzione geografica di *Signiphorina subaenea* Forst. (Hym., Chalc., Thysanidae), iperparasita dei Coccidi (*Pseudococcus* sp.). *Boll. Zool. Agric. Bachic. 20*: 203-212.

PECK, O. (1963): A catalogue of the Neartic Chalcidoidea (Insecta: Hymenoptera). *Cand. Ent. Suppl.* No. 30: 234-330.

PECK, O., BOUCEK, Z. AND HOFFER, A. (1964): Keys to Chalcidoidea of Czechoslovakia (Insecta: Hymenoptera). *Mem. entomol. Soc. Can.* No. 34; 120 pp.

ROSANOV, I. V. (1965): Review of genera of parasitic Hymenoptera of the family Signiphoridae (Hymenoptera, Chalcidoidea). *Ent. Obozr.* 44: 866-884 (In Russian). English translation in *Ent. Rev. 44*: 508-516.

SILVESTRI, F. (1918): *Thysanus* Walker (Hymenoptera, Chalcididae). *Boll. Lab. Zool. gen. Agrar. Portici. 12*: 266-271.

SUBBA RAO, B. R. (1957): Some new species of Indian Hymenoptera. *Proc. Indian Acad. Sci.,* (B) *46*: 376-390.

SUBBA RAO, B. R. (1974): The genera of Signiphoridae (Hymenoptera) with description of a new genus. *Bull. Ent. Res. 64*: 525-531.

NEW DESCRIPTIONS

THREE NEW SPECIES OF THE GENUS *NEOCHRYSOCHARIS* KURDYUMOV (EULOPHIDAE: ENTEDONTINAE) FROM INDIA[1]

M. YOUNUS KHAN AND S. ADAM SHAFEE[2]

(*With two plates*)

Additional generic characters of pronotum, subgenital plate and external female genitalia are suggested for the genus *Neochrysocharis* Kurdyumov. Key to Indian species of the genus *Neochrysocharis* is given. Three new species are described in detail. Types have been deposited in Zoological Museum, Aligarh Muslim University, Aligarh, India.

Genus *Neochrysocharis* Kurdyumov

Neochrysocharis Kurdyumov, 1912, *Russ. Ent. Rev.*, 12: 235.

Type-species : *Neochrysocharis immaculatus* Kurdyumov.

The genus *Neochrysocharis* was proposed by Kurdyumov (1912) for *Neochrysocharis immaculatus* Kurdyumov. Kerrich (1969) synonymised the genus *Proacrias* Ihering with *Neochrysocharis* Kurdyumov. Recently, Boucek (1977) revalidated the genus *Proacrias* Ihering on the basis of having carinae on mid of propodeum. The specimens under study resemble the genus *Neochrysocharis* Kurdyumov in keys to genera proposed by Nikol'skaya (1952) and Peck *et al.* (1964). We suggest some additional generic characters as follows: Pronotum of uniform width, anterior margin slightly concave, posterior margin more or less straight (Pl. 1, fig. D; Pl. 2, fig. B); first valvifers triangular with basal and apical angles at different levels (Pl. 1, fig. L; Pl. 2, fig. I); third valvulae short, movably articulated with second valvifers (Pl. 1, fig. M; Pl. 2, fig. J); subgenital plate narrow, posterior margin with a semicircular notch in middle (Pl. 1, fig. O; Pl. 2, fig. L).

KEY TO INDIAN SPECIES OF THE GENUS *Neochrysocharis* KURDYUMOV, BASED ON FEMALES

1. Disc of fore wings with hyaline setae; costal cell of fore wings much shorter than marginal vein; postmarginal vein shorter than stigmal vein. 2
— Disc of fore wings with coarse setae; costal cell of fore wings slightly shorter than marginal vein; postmarginal vein as long as stigmal vein (Pl. 2, fig. O & P); submarginal and marginal veins with 2 and 10 setae respectively; pedicel twice as long as wide; club three and a half times as long as wide....*N. pubipennis* sp. nov.
2. First funicle segment shorter than second; second funicle segment longer than wide (Pl. 1, fig. C); scape five times as long as wide; club four times as long as wide; marginal vein with 16 setae; axillae without transverse sutures. ....*N. hyalinipennis* sp. nov.
— Funicle segments first and second subequal in length; second funicle segment as long as wide (Pl. 2, fig. A); scape four times as long as wide; club three times as long as wide; mar-

[1] Accepted October 1979.

[2] Section of Entomology, Department of Zoology, Aligarh Muslim University, Aligarh, India.

ginal vein with 9 setae; axillae with transverse sutures. ....*N. metallicus* sp. nov.

Neochrysocharis hyalinipennis sp. nov.
(Plate 1, figs. A-P)

FEMALE

Head.—Dark with metallic bluish reflections and reticulately sculptured, wider than long in facial view; frontovertex slightly wider than long, width one-half the total head width; ocelli white, arranged in obtuse triangle, lateral ocelli less than their own diameters from orbital and occipital margins separately; eyes red and smooth; malar space one-half the eye width; malar sutures absent; antennae inserted above lower level of eyes; prominence between antennal sockets one-fourth the width of frons between eyes; scrobes deep and convergent above; frontal fork with arms obtusely diverging, apices touching the inner orbital margins; mandibles tridentate with two acute and one rudimentary teeth (fig. A); maxillary and labial palpi each 1-segmented (fig. B).

Antennae (fig. C).—Yellowish brown except basal two-third of scape which is white, 7-segmented excluding 2 indistinct ring segments; scape cylindrical, five and a half times as long as wide; pedicel one and a half times as long as wide, slightly longer than first funicle segment; funicle 2-segmented, first as long as wide and shorter than second, second distinctly longer than wide; club 3-segmented, four times as long as wide (0.17:0.04 mm), longer than funicle.

Thorax (fig. E).—Dark with metallic bluish green reflections; dorsum reticulately sculptured; pronotum of uniform width, anterior margin slightly concave, posterior margin straight bearing 3 pairs of setae (fig. D); parapsidal furrows distinct anteriorly and faint posteriorly; scutum and scutellum with 4 and 2 setae respectively; mesopostphragma not reaching beyond the propodeum; propodeum without median carina.

Fore wings (fig. G).—Hyaline, slightly less than twice as long as wide (0.94:0.5 mm), rounded at apex, disc with hyaline setae; a line of hairs extending obliquely apex of submarginal vein to the base of outer wing margin; costal cell narrow, shorter than marginal vein; submarginal and marginal veins with 2 and 16 setae respectively; postmarginal vein well developed, shorter than stigmal vein (fig. H); marginal fringe short, spaced by a distance equal to one-half their length.

Hind wings.—Hyaline, six times as long as wide; disc with hyaline setae; marginal fringe long, one-half the wing width.

Legs (figs. I-K).—White except coxae which are dark brown; tarsi 4-segmented; middle tibial spur shorter than basitarsus (fig. J).

Abdomen.—Brown with metallic reflections, slightly longer than head and thorax together, ovipositor slightly exserted, arising from basal one-third of abdominal venter; first valvifers triangular with basal and apical angles at different levels (fig. L); third valvulae three and a half times as long as wide, one-fifth the length of second valvifers (fig. M); outer plates of ovipositor slightly longer than second valvifers (fig. N); subgenital plate narrow, posterior margin with a small semicircular notch in middle (fig. O).

Length: 1.38 mm.

MALE

Resembles female except in the following characters:

Scape four times as long as wide; funicle segments first and second subequal, each distinctly longer than wide; club five and a half times as long as wide (fig. P); fore wings

twice as long as wide (0.88:0.44); submarginal vein with 3 setae; postmarginal vein about as long as stigmal vein (0.05:0.05 mm).

Length: 1.01 mm.

Holotype ♀, INDIA: Uttar Pradesh, Aligarh, University campus, ex unidentified scale on *Carica papaya*, 1.v.1977 (*M. Younus Khan*).

Paratypes. 3 ♀, 1 ♂ (same data as holotype).

Neochrysocharis metallicus sp. nov.
(Plate 2, figs. A-L)

FEMALE

Head.—Dark with metallic bluish reflections and reticulately sculptured, wider than long in facial view; frontovertex as long as wide, width slightly less than one-half the total head width; ocelli white, arranged in obtuse triangle, lateral ocelli by their own diameters from eye and occipital margins; eyes red and sparsely setose; antennae inserted above lower level of eyes; prominence between antennal sockets one-fourth the width of frons between eyes; malar space shorter than eye width; malar sutures absent; mandibles tridentate with two acute and one rudimentary teeth; maxillary and labial palpi each 1-segmented.

Antennae (fig. A).—Dark except scape which is yellow, 7-segmented excluding 2 indistinct ring segments; scape four times as long as wide (0.13:0.03 mm); pedicel slightly longer than wide, slightly longer than first funicle segment; funicle 2-segmented, segments first and second subequal, each about as long as wide; club 3-segmented, slightly less than three times as long as wide, much longer than funicle.

Thorax (fig. C).—Dark with metallic bluish reflections and reticulately sculptured; pronotum with anterior margin slightly concave, posterior margin slightly curved bearing 3 pairs of setae (fig. B); parapsidal furrows indicating anteriorly, reaching up to scutellum by grooves; scutum wider than long and with 4 setae; each parapside with a transverse suture; scutellum as long as wide and with a pair of setae; mesopostphragma short, not reaching beyond the propodeum; propodeum smooth and without median carina.

Fore wings.—Hyaline, twice as long as wide, disc with hyaline setae; a line of hairs extending obliquely apex of submarginal vein to the base of outer wing margin; costal cell shorter than marginal vein; submarginal and marginal veins with 2 and 9 setae respectively (fig. D); postmarginal vein well developed, shorter than stigmal vein (fig. E); marginal fringe short, spaced by a distance equal to one-third their length.

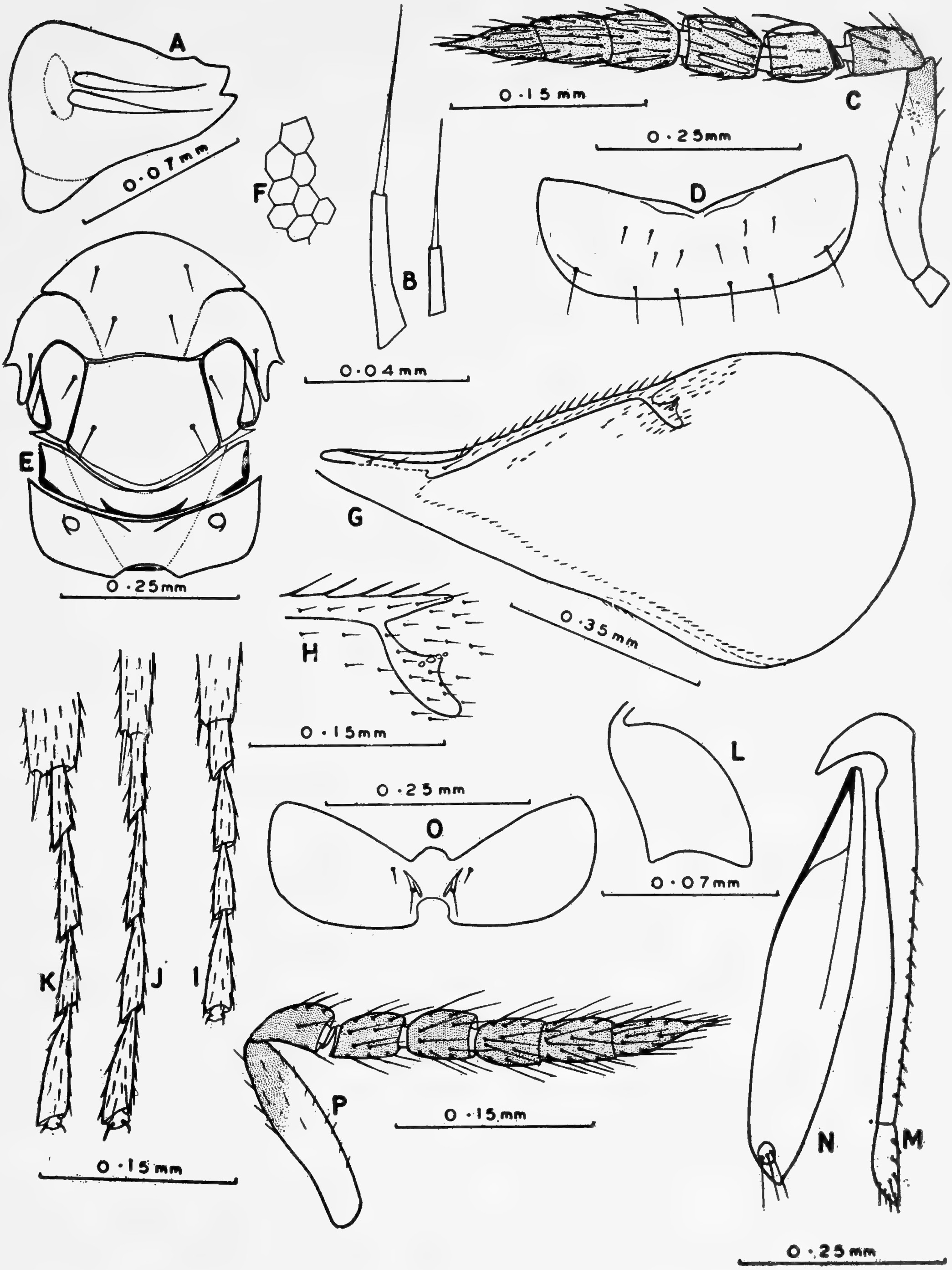
Hind wings.—Hyaline, five and a half times as long as wide, disc with hyaline setae; marginal fringe long, one-half the wing width.

Legs (figs. F-H).—White except coxae which are brown; middle tibial spur shorter than basitarsus (fig. G).

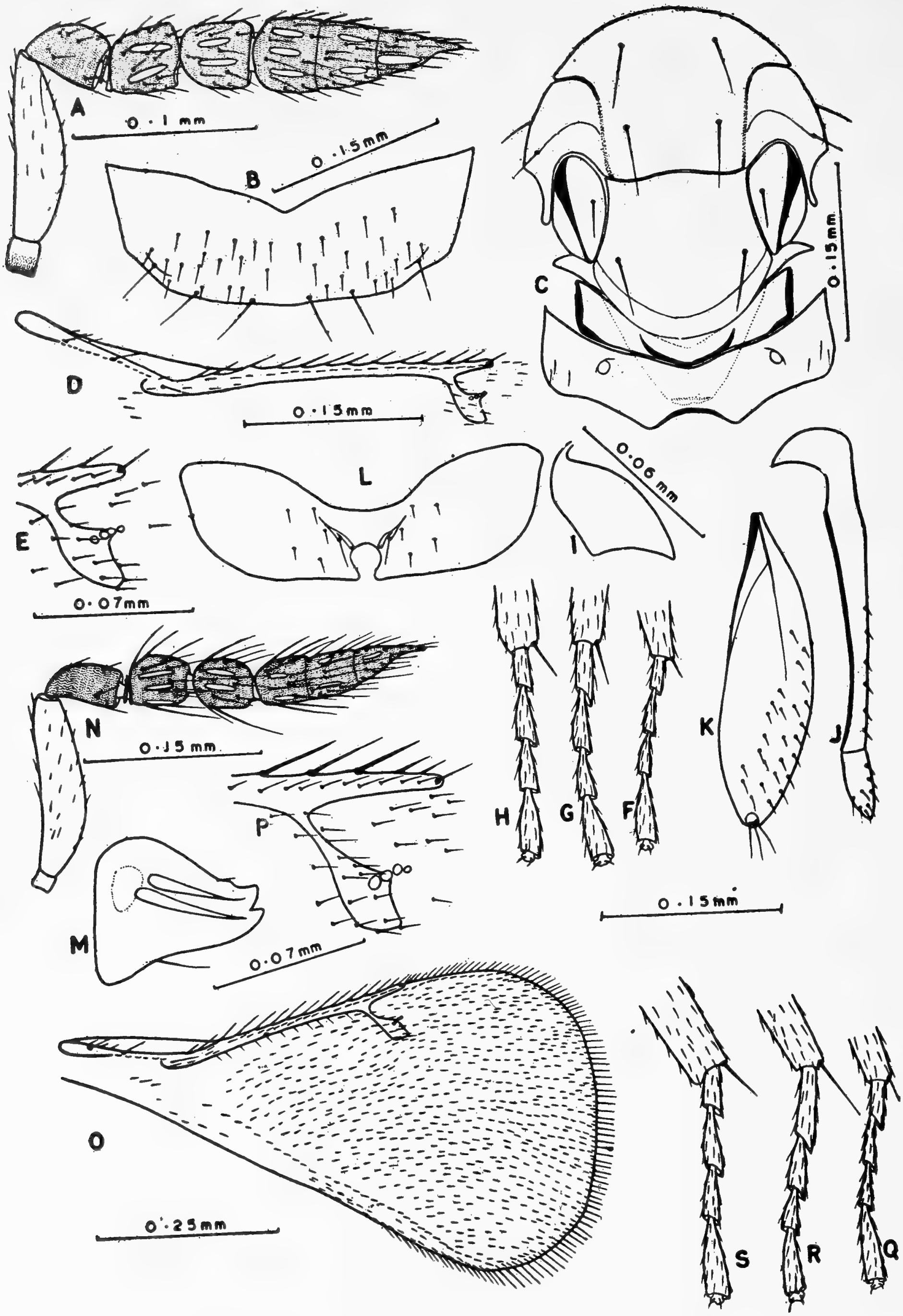
Abdomen.—Brown with metallic bluish reflections, about as long as head and thorax together; ovipositor slightly exserted, arising from basal one-third of abdominal venter; first valvifers triangular with basal and apical angles at different levels (fig. I); third valvulae two and a half times as long as wide and about one-fifth the length of second valvifers (fig. J); outer plates of ovipositor slightly shorter than second valvifers (fig. K); subgenital plate narrow, anterior margin deeply concave, posterior margin with a notch in middle (fig. L).

Length: 1.03 mm.

Holotype ♀, INDIA: Karnataka, Bangalore, ex unidentified scale on *Mangifera indica* Linn., 30.vi.1975 (*M. Younus Khan*).



Figs. A-P. *Neochrysocharis hyalinipennis* sp. nov., ♀, ♂: (A) Mandible, ♀; (B) Maxillary and labial palpi, ♀; (C) Antenna, ♀; (D) Pronotum, ♀; (E) Propodeum and part of thorax in dorsal view, ♀; (F) Sculpture of scutum, ♀; (G) Fore wing, ♀; (H) Part of fore wing venation, ♀; (I) Part of fore leg, ♀; (J) Part of middle leg, ♀; (K) Part of hind leg, ♀; (L) First valvifer, ♀; (M) Second valvifer and third valvula, ♀; (N) Outer plate of ovipositor, ♀; (O) Subgenital plate, ♀; (P) Antenna, ♂.



Figs. A-L. *Neochrysocharis metallicus* sp. nov. ♀: (A) Antenna, (B) Pronotum, (C) Propodeum and part of thorax in dorsal view, (D) Fore wing venation, (E) Part of fore wing venation, (F) Part of fore leg, (G) Part of middle leg, (H) Part of hind leg, (I) First valvifer, (J) Second valvifer and third valvula, (K) Outer plate of ovipositor, (L) Subgenital plate.

Figs. M-S. *Neochrysocharis pubipennis* sp. nov., ♀: (M) Mandible, (N) Antenna, (O) Fore wing, (P) Part of fore wing venation, (Q) Part of fore leg, (R) Part of middle leg, (S) Part of hind leg.

Paratype. 1 ♀ (same data as holotype).

Neochrysocharis pubipennis sp. nov.
(Plate 2, figs. M-S)

FEMALE

Head.—Dark with metallic bluish reflections and reticulately sculptured, wider than long in facial view; frontovertex wider than long, width more than one-half the total head width; ocelli reddish, arranged in obtuse triangle, lateral ocelli less than their own diameters from orbital and by their own diameters from occipital margin; eyes red and sparsely setose; antennae inserted just above lower level of eyes; prominence between antennal sockets one-third the width of frons between eyes; malar space shorter than eye width; malar sutures absent; mandibles tridentate with two acute and one rudimentary teeth (fig. M); maxillary and labial palpi each 1-segmented.

Antennae (fig. N).—Dark except scape which is yellow, 7-segmented excluding 2 indistinct ring segments; scape cylindrical, four times as long as wide (0.13:0.03 mm), about as long as club; pedicel slightly less than twice as long as wide, longer than first funicle segment; funicle 2-segmented, segments first and second subequal in length, each as long as wide; club 3-segmented, three and a half times as long as wide, longer than funicle.

Thorax.—Dark with metallic bluish reflections and reticulately sculptured; parapsidal and second subequal in length, each as long as wide and with 2 setae near each parapsidal furrow; scutellum with a pair of setae; mesopostphragma not reaching beyond the propodeum; propodeum smooth and without median carina.

Fore wings (fig. O).—Hyaline, slightly less than twice as long as wide (0.7:0.38 mm), apex broadly rounded, disc with coarse setae; a line of hairs extending obliquely apex of submarginal vein to the base of outer wing margin; costal cell slightly shorter than marginal vein; submarginal and marginal veins with 2 and 10 setae respectively; postmarginal vein well developed, as long as stigmal vein (fig. P); marginal fringe short, spaced by a distance equal to one-third their length.

Hind wings.—Hyaline; disc with coarse setae; marginal fringe long, one-half the wing width.

Legs (figs. Q-S).—Yellowish except coxae which are brown; mid tibial spur shorter than basitarsus (fig. R).

Abdomen.—Dark with metallic bluish reflections, slightly shorter than head and thorax together; ovipositor slightly exserted, arising from basal one-third of abdominal venter; third valvulae short, movably articulated with second valvifers.

Length: 1.03 mm.

Holotype ♀, INDIA: Uttar Pradesh, Aligarh, University Agriculture farm, ex *Pulvinaria maxima* Green on *Azadirachta indica*, 10.v.1977 (*M. Younus Khan*).

ACKNOWLEDGEMENTS

We are indebted to Prof. S. Mashhood Alam, Head, Department of Zoology, for providing research facilities. Thanks are also due to Prof. Nawab H. Khan for encouragement.

REFERENCES

BOUCEK, Z. (1977): Descriptions of two new species of Neotropical Eulophidae (Hymenoptera) of economic interest, with taxonomic notes on related species and genera. *Bull. ent. Res. 67*: 1-15.

KERRICH, G. J. (1969): Systematic studies on Eulophid parasites (Hym., Chalcidoidea), mostly of coffee leaf-miners in Africa. *Bull. ent. Res. 59*: 195-228.

KURDYUMOV, N. V. (1912): Hymenopteres-parasites nouveaux ou peu connus. *Rev. russe. Ent. 12*: 223-240.

NIKOL'SKAYA, M. N. (1952): The chalcid fauna of the USSR (Chalcidoidea). *Opred. Faun. Zool. Inst. Akad. Nauk SSSR 44*: 575 pp.

PECK, O., BOUCEK, Z. AND HO6FER, A. (1964): Keys to the Chalcidoidea of Czechoslovakia (Insecta: Hymenoptera). *Mem. ent. Soc. Canada, 34*: 120 pp.

RECORD OF GENUS *CAENOCHOLAX* PIERCE (MYRMECOLACIDAE, STREPSIPTERA) FROM INDIA[1]

A. K. CHATTOPADHYAY AND P. K. CHAUDHURI[2]

(*With four text-figures*)

The genus was erected by Pierce (1909) for a Mexican species, *Caenocholax fenysi* Pierce which was designated as the type species. The genus is characterised by seven segmented antenna with 3rd segment laterally produced into a long flabellum, fourth segment transverse, fifth, sixth and seventh elongated and flattened; wing having six primary veins with a short detached vein below the apex of R, short M being continued by a long detached vein; absence of Cu and A_3; four segmented tarsi without claw.

Terminologies and mode of species description presented in this paper have been followed after Bohart (1941, 1951), Chaudhuri *et al.* (1978), Pierce (1909, 1918) and Kinzelbach (1973).

Caenocholax pierci sp. nov.

MALE:

Body length 2.26 (n = 6) mm.

Wing length: 1.52 (1.50-1.52, n = 5) mm.

Head: Dark brown in colour and transverse. Eyes hairy, facets rounded and 18-20 in number. Maxillary palp with short transverse basal segment and the terminal segments long and flattened. Antenna (Fig. 1) brown seven segmented, first two segments cylindrical, third laterally produced into a long flabellum reaching up to the middle of segment VII being 1.05 mm long, fourth small and transverse, fifth elongated, largest and blunt, sixth and seventh cylindrical; length ratio of antennal segments I-VII 5:2:4:3:34:22:30.

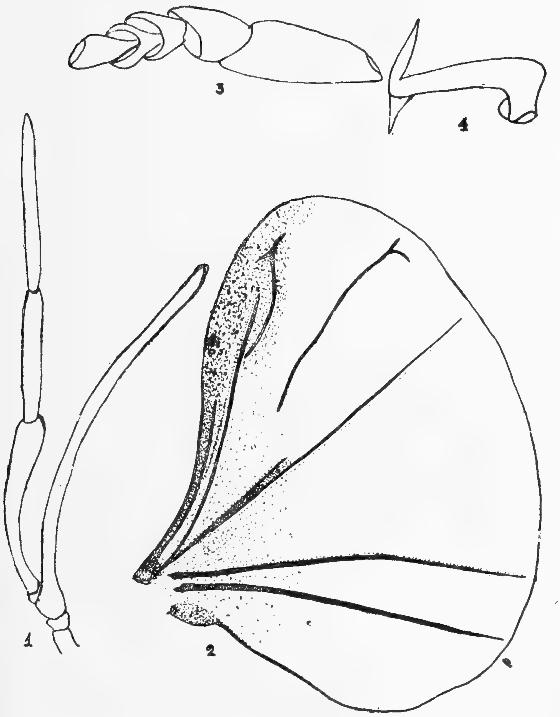
Thorax: Dark brown in colour. Pronotum small and inserted into broad, transverse mesonotum, scutum notched in the middle and united for some distance in the middle behind the prescutum, postscutellum large and tongue-shaped covering the base of first abdominal segment.

Wing (Fig. 2): Halteres with grey knob and

[1] Accepted November 1979.

[2] Department of Zoology, University of Burdwan, Burdwan 713 104, India.

white stem. Hind wing fan-like more or less transparent with pale margin and conspicuous veins. Six primary veins arise from the base: C dark brown reaches about half of the length of the wing; Sc separate and runs parallel to C ending a little behind C; R arises from the base and runs upto two-thirds of the total length of wing; R_2 and R_3 appear to be interrupted continuation of R and are free veins between R and M; R_2 bent and forked at the apex; R_3 little curved near the tip of the wing; M is contiguous with R but soon diverges extending a little behind the base of R_3; M_2 appears as an unattached vein running parallel to M and ends near the margin; A_1 arises below the base of M and diverges ending at the margin of wing; A_2 more or less similar to A_1 but bent at the middle.



Figs. 1-4. *Caenocholax pierci* sp. nov. ♂; 1) antenna; 2) wing; 3) hind tarsomeres I-IV and 4) aedeagus.

Legs (Fig. 3): Fore and mid coxa transverse, hind coxa shorter, trochanters stout and larger than femur in fore and mid legs; hind trochanter short; femur almost as long as tibia in fore and mid legs, hind femur and tibia shorter; tarsi four segmented and funnel-shaped without any claw; tarsomere I of fore and mid legs larger than those of the hind; length ratio of tarsomeres from I-IV 16:6:4:5 in fore 14:6:6:5 in mid and 4:3:3:4 in hind leg.

Abdomen: Tergite IX backwardly produced and encloses the genital cavity. Aedeagus (Fig. 4) more or less plough shaped with sharply pointed tip.

Female: Unknown.

Material: Holotype male (Type no. 90, B.U. Ent.), India, West Bengal, Kantaticar (Burdwan), 24.4.1979, Coll. Miss S. Sarkar. Paratypes 8 males, data same as holotype and will be deposited to the Zoological Survey of India, Calcutta and U.S.N.M., Washington D.C.

The species is dedicated to late Dr. W. D. Pierce for his outstanding contribution to the study of this peculiar group of insects. It seems close to *Caenocholax fenysi* Pierce (1909, 1918) from Mexico in general morphology and the male genitalia but its identity as a distinct and valid species is evident from the structure of veins, halteres, legs and the aedeagus of male genitalia.

Acknowledgements

We are grateful to Prof. D. K. Chaudhuri, Head of the Department of Zoology for laboratory facilities and to Prof. S. K. Das Gupta, Head of the Department of Zoology, Presidency College, Calcutta for advice.

References

BOHART, R. M. (1941): A revision of Strepsipters with special reference to the species of North America. *Univ. Calif. Pub. Ent. 7*: 91-160.

——————— (1951): The Myrmecolacidae of the Philippines (Strepsiptera). *Wasmann J. Bio. 9*: 83-103.

CHAUDHURI, P. K., DAS GUPTA, S. K. AND CHATTOPADHYAY, A. K. (1978): Description of a new species of Parastylops (Strepsiptera, Stylopidae) from Arunachal Pradesh. *Oriental Ins. 12* (3): 378-389.

KINZELBACH, R. (1973): Die Facherfluger des Senckenberg—Museum II. Mengenellidae (Insecta, Strepsiptera). *Senkenbergiana biol. 53* (5/6): 403-413.

PIERCE, W. D. (1909): A monographic revision of the twisted winged insects comprising order Strepsiptera Kirby. *Bull. U.S. Natl. Mus. 66*: 1-232.

——————— (1918): The comparative morphology of the order Strepsiptera together with records and descriptions of insects. *Proc. U.S. Natl. Mus., 54*: 381-501.

MISCELLANEOUS NOTES

1. THE GOLDEN LANGUR, *PRESBYTIS GEEI* KHAJURIA IN BHUTAN

The Golden Langur *Presbytis geei* Khajuria, a beautiful species of colobine monkey, was discovered only as recently as 1956, and has so far, remained little known. Most of the relevant researches were confined to the Himalayan foothills along the Assam-Bhutan border in Jamduar-Raimona area on the bank of the Sankosh river, and subsequently to the Manas Sanctuary on the bank of the Manas river, Bhutan, the little montane kingdom in the eastern Himalaya, adjacent to the known range of the Golden Langur, unexplored because this country remained largely isolated from the rest of the world until recently. Zoological explorations in different regions of that country began since 1966. The present paper is aimed to record the field investigations carried out by the Zoological Survey of India Expedition team on the Golden Langur.

Occurrence of the Golden Langur, ascribed in the earlier reports, was in a very limited area in Assam, confined to the foothills of Assam-Bhutan border in Jamduar-Raimona area in the Raimona Forest Range in the Goalpara district of Assam (Gee 1956, 1961; Khajuria 1956, 1962). Wayre (1968) for the first time observed it in the Bhutan part of the Manas Sanctuary away from its type locality, extending its range further eastward to the bank of the Manas river on the northern fringe of the Kamrup district of Assam (which was confirmed by several other workers). The Bhutan Expeditions of the Zoological Survey of India, for the first time, obtained specimens in Bhutan and established that the chief centre of abundance of *Presbytis geei* Khajuria lies in the forests of the Black Mountain Range of Central Bhutan. The habitat preference of the Golden Langur, as observed, is in the deep ravines and gorges along the hill slopes in evergreen forests of diverse nature. The actual limits of the range of this species, based on our observations, are between Sankosh basin in the west to Manas basin in the east, and from the Assam-Bhutan border foothills in the south to the inner Himalayan range in the north, centering the Black Mountain Range in the Central Bhutan. Altitudinally, it ranges from the foothills (*c.* 150 m) to a height of *c.* 3000 m above the sea level. This beautiful species of colobine monkey has a closer affinity to the Indo-Chinese elements.

Zonal records of troops of the Golden Langur as observed in Bhutan (from west to east) are:

Western Bhutan. In the upper reaches of the Sankosh river, locally called Puna Chang Chu: troops were seen below Do Chu La, *c.* 30 km west of Wangdiphodrang.

At the foothills, where Sankosh meets the plains: troops were seen in the Bhutanese territory adjacent to the Jamduar area.

Central Bhutan. In the Aie Chu valley at the foothills: troops were seen in the dense forests between Sarbhang and Gaylegphug.

In the Mangde Chu valley: in the magnificent forests all along the road from Gaylegphug to Tongsa, troops of the Golden Langur

were seen. In these two valleys the following places in particular are worth mentioning: Gaylegphug, Tatapani, Samkhara, Batase, Tama, Mangdechu, Dakpai *c.* 15 km south of Shamgong, Wangregongchu *c.* 15 km north of Shamgong, Pangjurmane and also along the Tongsa Chu below Tongsa.

Eastern Bhutan. In the Manas river basin: troops were seen in the foothills where the Manas river meets the plains, near Mothanguri in the Manas Sanctuary, and in the upper reaches along the various tributaries of the Manas river, namely Bumthang Chu, Kuru Chu and Dangma Chu to the altitude of about 3000 m. And to further east, along the road from Samdrup Jongkhar to Tashigong, particularly at Gomchu and Yomphula troops were seen.

Before dealing on the abundance of the species in Bhutan, as evidenced by a number of troops and individuals observed, it will be worthwhile to mention here the historical report on the observation of apparently the Golden Langur before this species formally came to be known to science. The account is by Pemberton (1839) who in his "Report on Bootan" on the results of Pemberton's Mission in 1838, mentions under the caption 'Wild Animals and Birds': "...some monkeys ...and a very remarkable variety was observed by Dr. Griffith, in the glen through which the Mateesam river flows below Tongso, 5,417 feet above the sea; this species he described as perfectly white, with a long pendant tail, and would appear to be a new variety". Mateesam river is the Mangde Chu of today and Tongso is Tongsa Dzong. Some 50 km south of the place of reference by Capt. Pemberton lies Pangjurmane where Dr. Biswas collected his second specimen of the Golden Langur in Bhutan out of a troop in 1967.

The Bhutan expeditions of the Zoological Survey of India in 1966, 1967, 1969, 1973 and in 1978 critically investigated the occurrence and other aspects of the Golden Langur. Although only two specimens were collected, one from Gaylegphug (alt. *c.* 150 m) and the second from Pangjurmane (alt. *c.* 1525 m) in 1967 (cf. Chakraborty 1975), these are the first record of specimens taken in Bhutan.

In different trips, approximately 1250 individuals in 67 troops were actually counted by us in Bhutan making, an average of about 18.658 (range 12-27 individuals) per troop, higher than the estimated troop size as 12.5 $\pm$ 4.154 (range 12-18 individuals) in a normal bisexual troop accounted by Mukherjee and Saha (1974) in Jamduar-Raimona area in the plains of Assam adjacent to the foothills of Assam-Bhutan border. The break-up of the troops may be presented as:

In Western Bhutan. i) In foothill (Jamduar area): 4 troops 50 individuals; ii) in upper reaches of the Sankosh basin: 5 troops 90 individuals.

In Central Bhutan. i) In foothills (Aie valley): 20 troops 350 individuals; ii) In upper reaches (Mangde Chu valley): 25 troops 500 individuals.

In Eastern Bhutan. i) In foothills (Manas area): 5 troops 60 individuals; ii) In upper reaches (above 1000 m alt.): 8 troops 150 individuals.

Although the above figures do not give the total picture of the Golden Langur population in Bhutan as the count was made only along roadside forests, they definitely indicate a larger troop size and more abundance in Central Bhutan than in its peripheral limits particularly in the adjoining Indian territory in the foothills in Goalpara district of Assam. It is also apparent on the basis of observations available from Assam and Bhutan that, in fact, the Golden Langur is a Bhutanese species

whose southern limit happens to be on the Bhutan-Assam border, so that only a marginal part of its range lies within the Indian territory. And obviously for its meagre records from the limited study area in Assam-Bhutan border, it was, so far, regarded as a rare species of primates and included in the list of vanishing and endangered species of wildlife. To the contrary, the Golden Langur, non-aggressive, docile and forest-dwelling monkey, a unique discovery of recent times, is thriving well and has a peaceful home in the luxuriant forests in the lap of the sacred and unperturbed grandeur of the Black Mountain in Central Bhutan, in the little montane kingdom of Bhutan, the dragonland.

I acknowledge my debt of gratitude to Drs. K. K. Tiwari and B. Biswas for guiding me in the preparation of this manuscript and to the latter in particular, I express my sincere regards for encouraging me constantly in the field when I accompanied him in his zoological expeditions in Bhutan which enabled me to carry out the investigations.

SUBHENDU SEKHAR SAHA

Zoological Survey of India,
Indian Museum,
27 J. L. Nehru Road,
Calcutta 700 016,
October 11, 1978.

References

Chakraborty, S. (1975): On a collection of mammals from Bhutan. *Rec. zool. Surv.* 68: 1-20.

Gee, E. P. (1956): A new species of langur in Assam. *J. Bombay nat. Hist. Soc.* 53: 252-254.

Khajuria, H. (1956): A new langur (Primates: Colobidae) from Goalpara district, Assam. *Ann. Mag. nat. Hist.* 12 (9): 86-88.

——————— (1961): The distribution and feeding habits of the Golden Langur, *Presbytis geei* Gee (Khajuria, 1956). ibid. 58: 1-12.

——————— (1962): Further observations on the Gee's Langur, *Presbytis geei* Khajuria, 1956, with remarks on the classification of Indian Colobidae (Mammalia: Primates). *Rec. Indian Mus.* 58(2): 123-130.

Mukherjee, R .P. & Saha, S. S. (1974): The Golden Langur (*Presbytis geei* Khajuria, 1956) of Assam. *Primates* 15: 327-340.

Pemberton, R. B. (1839): Report on Bootan. Bengal Military Orphan Press, Calcutta. (Reprinted 1961).

Wayre, P. (1968): Some observations on the Golden Langur, *Presbytis geei* (MS. Khajuria) Gee. *J. Bombay nat. Hist. Soc.* 65 (2): 473-477.

2. SOME OBSERVATIONS ON INTER-OESTRUS INTERVAL IN CAPTIVE TIGRESSES [*PANTHERA TIGRIS* (LINNAEUS)]

The Felidae appear to be seasonally polyoestrus in temperate regions and completely polyoestrus in tropical regions (Asdell 1964). About cats in general Prater (1971) states that no definite knowledge is available about sexual periodicity and the intervals of time which elapse between the periods when females are in condition to breed. The present communication gives some data on the interoestrus interval of the tigress (*Panthera tigris*) observed at Nandankanan Biological Park, Orissa during the period from September, 1970 to August, 1977.

The tigers of the Park are kept in pairs and

TABLE

Sl. No.	Name of the tigress	Date of last mating observed (oestrus period) without conception	Dates of subsequent mating observed (oestrus period) with or without conception	Inter-oestrus interval in days
1	2	3	4	5
1.	Tigress "Rani"	3-9-1970 to 5-9-1970 (3 days)	22-12-1970 to 25-12-1970 (4 days)	107
2.	,,	22-12-1970 to 25-12-1970 (4 days)	2-4-1971 to 6-4-1971 (5 days)	97
3.	,,	2-4-1971 to 6-4-1971 (5 days)	1-6-1971 to 5-6-1971 (5 days)	55
4.	,,	1-6-1971 to 5-6-1971 (5 days)	23-7-1971 to 27-7-1971 (5 days)	47
5.	,,	4-6-1974 to 11-6-1974 (8 days)	2-8-1974 to 6-8-1974 (5 days)	51
6.	,,	2-8-1974 to 6-8-1974 (5 days)	23-9-1974 to 29-9-1974 (7 days)	47
7.	,,	21-6-1976 to 27-6-1976 (7 days)	13-11-1976 to 20-11-1976 (8 days)	138
8.	,,	13-11-1976 to 20-11-1976 (8 days)	3-2-1977 to 10-2-1977 (8 days)	74
9.	Tigress "Rekha"	6-12-1975 to 7-12-1975 (2 days)	4-1-1976 to 6-1-1976 (3 days)	27
10.	,,	4-1-1976 to 6-1-1976 (3 days)	1-2-1976 to 4-2-1976 (4 days)	25
11.	,,	1-2-1976 to 4-2-1976 (4 days)	24-3-1976 to 26-3-1976 (3 days)	48
12.	,,	24-3-1976 to 26-3-1976 (3 days)	7-5-1976 to 10-5-1976 (4 days)	41
13.	,,	7-5-1976 to 10-5-1976 (4 days)	26-6-1976 to 30-6-1976 (5 days)	46
14.	,,	26-6-1976 to 30-6-1976 (5 days)	29-8-1976 to 4-9-1976 (7 days)	59
15.	,,	29-8-1976 to 4-9-1976 (7 days)	9-1-1977 to 14-1-1977 (6 days)	126

the expectant mothers are separated about a fortnight before the expected date of parturition till the cubs are about 9 months old. The observed period of mating is taken as the period of oestrus.

Observations

The details of our observations are given in the Table.

Discussion

A study of the table reveals that the interoestrus interval observed in fifteen cases among two tigresses varies from 25 to 138 days with an average of 65.9 days. The oestrus period observed in nineteen cases among these two tigresses varies from 2 to 8 days with an average of 5.2 days. One or the other tigress was in oestrus in all the months of the year except in October.

Schaller (1972) reports that the oestrus in one tigress at the Basel Zoo was observed 21 times with an average interval of 51.9 days (range 20-84 days), and in another tigress it was recorded 18 times with an average interval of 54.2 days (range 27-83 days). Sadleir (1966) states that the interval between midpoints of 3 consecutive oestrus periods in one tigress varied from 45 to 55 days and the average length of receptivity during 14 oestrus periods was 7.1 days. The tiger breeds all the year (Asdell, loc. cit.). According to Crandall (1965) the female of this species is polyoestrus, heat recurring at intervals of about 3 weeks and receptivity continues for about 5 days.

Summary

The present communication embodies data on interoestrus interval of tigress (*Panthera tigris*) observed at Nandankanan Biological Park, Orissa during the period from September, 1970 to August, 1977.

The interoestrus interval observed in fifteen cases among two tigresses varies from 25 to 138 days with an average of 65.9 days. The oestrus period observed in nineteen cases among these two tigresses varies from 2 to 8 days with an average of 5.2 days. The observations of earlier workers have been cited.

Acknowledgements

We are grateful to Sri S. Jee, I.F.S., Chief Conservator of Forests, Orissa, Cuttack and to Sri G M. Das, I.F.S., Chief Wildlife Warden, Orissa, Bhubaneswar for their encouragement.

VETERINARY ASSISTANT SURGEON,
NANDANKANAN BIOLIGICAL PARK,
P.O. BARANG, DIST: CUTTACK.

L. N. ACHARJYO

WILDLIFE CONSERVATION OFFICER,
95 SAHEED NAGAR,
BHUBANESWAR 751 007,

S. MOHAPATRA

February 28, 1978.

References

ASDELL, S. A. (1964): Patterns of Mammalian Reproduction, Second Edition, Cornell University Press, Ithaca, New York, pp. 425-493.

CRANDALL, LEE S. (1965): The Management of Wild Mammals in Captivity. The University of Chicago Press, Chicago and London, pp. 359-385.

PRATER, S. H. (1971): The Book of Indian Animals, Bombay Natural History Society, Bombay, pp. 63-66.

SADLEIR, R. (1966): Cited by Schaller, G. B. (1972).

SCHALLER, G. B. (1972): The Deer and the Tiger. The University of Chicago Press, Chicago and London, pp. 231.

3. HABITATS, FEEDING, BREEDING AND REACTION TO MAN OF THE DESERT CAT *FELIS LIBYCA* (GRAY) IN THE INDIAN DESERT

Prater (THE BOOK OF INDIAN ANIMALS, 1971) states that very little is known about the habits of this cat except that it lives in desert and scrub jungle and preys mainly on desert gerbilles and other small rodents and birds. Breeding habits are not known. I studied the habitat preferences, food habits and breeding biology of the Desert Cat in the Indian desert in Western Rajasthan from January 1974 to April 1977.

Habitat. Scrub wasteland is the typical habitat. In the Indian desert, thickets of *Maytenus emarginatus, Acacia modesta, Salvadora* spp., and those particularly of *Capparis decidua* provide suitable haunts for the desert cat. In saline soil areas, the cat was observed in thickets of *Tamarix dioica*. It is noteworthy that *Prosopis juliflora* is spreading extensively in various regions of the Indian desert; this tree provides favourable habitat for the cat. A number of this cat were seen commonly in thick scrub close to tanks, probably because prey species are available there.

Food habits. Prater's surmise that, the Desert Cat largely lives on the desert gerbille (*Meriones hurrianae*) was found to be correct, analysis of droppings showed a very high percentage (about 10%) of hairs of the hare (*Lepus* sp.). The cat ambushes the gerbilles close to their burrows. But it was noted that often gerbilles succeeded in escaping into their burrows, younger gerbilles which are less aware and careless, fall easy victims.

The Desert Cat was observed hunting hare, doves (*Streptopelia decaocto* and *S. senegalensis*), grey partridge (*Francolinus pondicerianus*), sandgrouse (*Pterocles exustus*), peafowl (*Pavo cristatus*), bulbuls (*Pycnonotus cafer, P. leucogenys*) in jungles and the house sparrow (*Passer domesticus*), rats (*Rattus* spp.) and the blue-rock pigeon (*Columba livia*), etc. in agricultural farms. The cat hunts its prey on trees and also from the tree, it pounces on the unwary hare, partridge and peafowl on the ground, under the tree.

It was also observed killing snakes such as the cobra (*Naja naja*), the Sawscaled viper (*Echis carinatus*) and the Sand boa (*Eryx johnii*). First the cat injures the snake at the hind quarters by striking with its paws; when the snake becomes exhausted, the neck of the snake is bitten and the snake killed. Some portions of the killed snake are eaten by the cat. Usually the attacked snake succeeds in escaping into a nearby bush, burrow or pile of stones after the first or second charge by the cat.

The cat also kills and eats the gecko (*Hemidactylus* spp.), scorpions and large beetles. It also robs clutches and broods of birds particularly ground birds such as the partridge, the peafowl and the sandgrouse.

Breeding. The desert cat breeds in the winter, in October and between February to April. The litter size was observed to be 3 to 5 usually, 4. The breeding site was often a den having three openings of about 20×15 cm, in different directions situated in a hummock with a bush growing over it, preferably surrounded by colonies of gerbilles. Such breeding sites seem to be provide enough food (gerbilles) for the young as well as protection from enemies, e.g. the stray dog and the Jungle cat (*Felis chaus*). In farms, the desert cat was observed breeding in a hollow in a fodder stack.

The cat was observed teaching her young by putting half killed gerbilles before her kittens. The young were seen attempting to hunt (kill) the injured gerbille. The cat was also seen bringing beetles and eggs of ground birds for her young.

Two young of the cat were seen killed by stray dogs of a nearby village and three young by male cats of the area.

Enemies. The jackal (*Canis aureus*), the wolf (*C. lupus*) and the stray dog are enemies of the desert cat. The cat escapes by climbing up a nearby tree or hiding under a thick bush when chased. in agonistic behaviour, it was observed erecting the hairs of its body, particularly of the tail, and if necessary striking at the mouth and nose of the enemy with its paws in an effort to escape. The cat was observed to be fairly successful in avoiding fatal attacks by dogs by this method. It falls a victim only when encircled by two or more dogs.

The desert cat was found to be a notable factor in controlling the population of the desert gerbilles in the sandy scrub wasteland. There is no serious predator of the cat but its population is restricted by poor breeding success, because of the young being often killed by males of its own species and stray dogs of nearby village areas.

INDRA KUMAR SHARMA

BHAGAWATI BHAVAN,
RATANADA ROAD,
JODHPUR 342 020,
May 10, 1978.

4. INTER-SPECIFIC RELATIONSHIP IN SOME SPECIES OF INDIAN BATS WITH A NOTE ON BAT FAUNA OF BHUBANESWAR

INTRODUCTION

An extensive survey of bats from Bhubaneswar and its vicinity was made by me between 1972 to 1976 for approximately four years, to study their ecology and reproductive biology. Bhubaneswar (20° 30′N, 85° 30′E) is situated near the eastern coast at 45 metres a.s.l. and there is neither extreme cold nor extreme heat. The rainfall ranges between 100 to 200 cm. and the annual temperature ranges from 10.6°C. to 43.3°C. The bats were captured from old temples, caves, old and deserted houses, cowsheds, palm trees, etc.

The present report on inter-specific relationship in some species of Indian bats is an outcome of this survey.

Taphozous melanopogon (Emballonuridae) colonies of a few hundred specimens, were seen inhabiting most of the temples at Bhubaneswar, Orissa.

Monthwise collections of *Taphozous melanopogon* was made from Mausima, Bhaskaresvara and Brahmesvara temples for over three years for studying its ecology and reproductive biology (Khaparde 1976)[1]. Frequent collections (several times a month) of *Taphozous melanopogon* were made during the breeding season from the above temples with a view to obtain closely graded stages

[1] KHAPARDE, M. S. (1976): Notes on the breeding habits of the Indian sheath-tailed bat, *Taphozous melanopogon* (Temminck). *J. Bombay nat. Hist. Soc. 73* (2): 321-324.

of development for embryological studies.

In Meghesvara temple, *Rousettus leschenaulti* (Pteropidae) lives in association with *Taphozous melanopogon* in November, December and January but during collections in February, March, April and May only *Taphozous melanopogon* were captured. Unfortunately, collections during other months of the year could not be made, and hence it is not possible to determine the exact time of migration of *Rousettus leschenaulti* of this temple.

In Rajrani temple, *Rhinopoma kinneari* (Rhinopomatidae) roosts with *Taphozous melanopogon* in November, December, and January but is absent in February, March and April. Collections could not be made during other months of the year.

Rhinopoma hardwickei hardwickei (Rhinopomatidae) roosts with *Taphozous melanopogon* in Mausima (Ramesvara) temple. Since, *Rhinopoma hardwickei hardwickei* roosts in small colonies of 20 to 30 specimens, only a few specimens of these could be captured alongwith the specimens of *Taphozous melanopogon* in a few of the total number of captures. But this does not rule out the possibility of the availability of *Rhinopoma hardwickei hardwickei* in association with *Taphozous melanopogon* in this temple throughout the year. *Taphozous melanopogon* is found in its roosts throughout the year.

In a small temple opposite Mausima temple, a colony of *Rhinopoma hardwickei hardwickei* consisting of 20 to 30 specimens exists. A large colony of *Rousettus leschenaulti* (Pteropidae) was noted in Jambesvara Temple. *Megaderma* sp. also occurs in temples and the Parasuramesvara temple holds a colony of *Megaderma* sp. were also captured from holes in bamboo in houses made of bamboo from a small village near Bhubaneswar.

Taphozous melanopogon (Emballonuridae); *Rhinopoma h. hardwickei* (Rhinopomatidae); *Rhinolophus rouxi* (Rhinolophidae); *Hipposideros speoris* (Hipposideridae) were collected from Rani Gumpha, Udayagiri Hill near Bhubaneswar. *Pteropus* sp. from a colony near Chandani Chowk, in Cuttack, Orissa. *Pipistrellus minus minus* (Vespertilionidae) were collected from huts in Bhubaneswar and *Cynopterus sphinx* (Pteropidae) from palm trees.

It was noted that the large sized bats generally live in colonies of their own species, while the smaller bats live with members of other species also.

ACKNOWLEDGEMENTS

I am grateful to Dr. Karl F. Koopman, American Museum of Natural History, New York, for identifying the specimens of *Rhinopoma hardwickei hardwickei*, and the experts at the Zoological Survey of India, Calcutta, for identifying the specimens of *Taphozous melanopogon* and *Rousettus leschenaulti*.

The author has great pleasure in acknowledging the help of Shri Purna Chandra Beura, Bhubaneswar, in capturing bats.

M. S. KHAPARDE[2]

DEPARTMENT OF ZOOLOGY,
REGIONAL COLLEGE OF EDUCATION,
BHUBANESWAR 751 007, (ORISSA),
April 22, 1977.

[2] *Present Address*: Department of Text books, NCERT, NIE Campus, New Delhi 110 016.

5. REPRODUCTIVE ACTIVITY OF FOUR SPECIES OF FIELD-RATS IN CROP FIELDS AT LUDHIANA

For devising efficient control measures against any pest, the knowledge of its reproductive activity is necessary. As the rodents are poly-oestrous, there is no season to which breeding is strictly confined. Fertility may be low at certain times of the year; but if so, the cause is usually to be some external factor (Barnett & Ishwar Prakash 1975). The point of lowest reproductive activity indicates the break in the reproductive cycle and, thus, the most appropriate time for mounting control operations. Studies on the field-rats concerning this aspect were done and the information collected on the subject during the period of December 1970 to November 1972 is presented here.

Materials and Methods

To obtain information on the reproductive activity of different species of field-rats, 'capture, mark, release and recapture method,' as described by Davis (1964) was employed. The traps were laid during December 1970 to November 1972 for a 10-day period in the first fortnight of each month in different crops at a 100 m distance from one another in a grid of 53 hectare cultivated area on the Ludhiana Farm of the Punjab Agricultural University. The traps were baited with a mixture of husked rice, pearl-millet and wheat. The trapped individuals were examined daily for sex, position of testes (scrotal or abdominal) in males and of vagina perforated or imperforated) in females. When the tests were abdominal, the black loose skin of the scrotum indicated that they were earlier scrotal. In the absence of black loose scrotal skin the abdominal condition of the testes indicated that the specimen was a subadult. In females, the previous history of the animal indicated whether it was an adult or subadult. Presence of clear teats was taken to indicate lactating condition.

Results and Discussion

The 1077 animals observed consisted of 841 *Rattus meltada* (Gray), 161 *Tatera indica* (Hardwicke), 33 *Golunda ellioti* (Gray) and 42 *Bandicota bengalensis* (Gray). Their reproductive activity is discussed below specieswise.

1. **Rattus meltada** (Gray). Scrotal males predominated throughout the year, except during November to February. Reproductively active females were present throughout the year, except during November and December and the lactating females were present throughout the year, except during December and January. Subadults were found during all the months. The peak lactating period was observed during July to September (Table 1). Similarly, Guraya & Gupta (1975) reported that this species did not breed in winter and the peak breeding activity was observed during July to October. Thus, from the above it may be concluded that this rat breeds throughout the year, except during the winter months.

2. **Tatera indica** (Hardwicke). None were found during December. During the remaining months, scrotal males were found to predominate, except during November. Reproductively active females were present throughout the year, except during May, October and November. The lactating females were present throughout the year, except during January to April, the peak being reached during May to October. Subadults were found

TABLE 1

REPRODUCTIVE STATUS OF *Rattus meltada* (GRAY) TRAPPED IN DIFFERENT MONTHS DURING DECEMBER 1970—NOVEMBER 1972

Month	Male				Female				
	Scrotal	Abdominal	Subadult	Total	Per-forated	Lactating	Imper-forated	Sub-adult	Total
December	NA	5(83)	1(17)	6	NA	NA	NA	4(100)	4
January	NA	13(100)	NA	13	3(30)	NA	NA	7(70)	10
February	3(10)	27(90)	NA	30	17(55)	1(3)	NA	13(42)	31
March	24(83)	4(14)	1(3)	29	15(71)	5(24)	1(5)	NA	21
April	8(80)	NA	2(20)	10	5(83)	1(17)	NA	NA	6
May	31(86)	1(3)	4(11)	36	7(47)	5(33)	1(7)	2(13)	15
June	14(82)	NA	3(18)	17	5(42)	4(33)	NA	3(25)	12
July	95(97)	NA	3(3)	98	9(15)	48(80)	NA	3(5)	60
August	66(94)	NA	4(6)	70	10(17)	42(71)	NA	7(12)	59
September	71(79)	NA	19(21)	90	8(7)	78(68)	7(6)	22(19)	115
October	19(59)	7(22)	6(19)	32	5(15)	11(33)	1(3)	16(49)	33
November	NA	15(71)	6(29)	21	NA	7(30)	3(13)	13(57)	23
Total	331(73)	72(16)	49(11)	452	84(22)	202(52)	13(3)	90(23)	389

Figures in the parentheses are per cent of animals falling in that category.
NA = No animal was found in this category.

TABLE 2

REPRODUCTIVE STATUS OF *Tatera indica* (HARDWICKE) TRAPPED IN DIFFERENT MONTHS DURING DECEMBER 1970—NOVEMBER 1972

Month	Male				Female				
	Scrotal	Abdominal	Subadult	Total	Per-forated	Lactating	Imper-forated	Sub-adult	Total
December	NA	NA	NA	NA	NA	NA	NA	NA	NA
January	1(50)	1(50)	NA	2	1(50)	NA	1(50)	NA	2
February	1(100)	NA	NA	1	2(67)	NA	NA	1(33)	3
March	8(80)	1(10)	1(10)	10	8(73)	NA	NA	3(27)	11
April	2(100)	NA	NA	2	1(100)	NA	NA	NA	1
May	2(100)	NA	NA	2	NA	1(50)	NA	1(50)	2
June	3(75)	1(25)	NA	4	1(50)	1(50)	NA	NA	2
July	9(100)	NA	NA	9	1(11)	4(44)	NA	4(45)	9
August	15(71)	1(5)	5(24)	21	1(8)	7(54)	NA	5(38)	13
September	17(85)	NA	3(15)	20	4(27)	9(60)	NA	2(13)	15
October	4(40)	3(30)	3(30)	10	NA	6(60)	1(10)	3(30)	10
November	NA	3(60)	2(40)	5	NA	1(14)	1(14)	5(71)	7
Total	62(72)	10(12)	14(16)	86	19(25)	29(39)	3(4)	24(32)	75

Figures in the parentheses are per cent of animals falling in that category.
NA = No animal was found in this category.

TABLE 3

REPRODUCTIVE STATUS OF *Golunda elliotti* (GRAY) TRAPPED IN DIFFERENT MONTHS DURING DECEMBER 1970—NOVEMBER 1972

Month	Male				Female				
	Scrotal	Abdominal	Subadult	Total	Per-forated	Lactating	Imper-forated	Sub-adult	Total
December	NA	NA	NA	NA		NA	NA	1(100)	1
January	NA	NA	NA	NA		NA	NA	NA	NA
February	2(67)	1(33)	NA	3		NA	NA	1(100)	1
March	2(100)	NA	NA	2		1(100)	NA	NA	1
April	NA	NA	NA	NA		NA	1	NA	1
May	3(100)	NA	NA	3		NA	NA	1(100)	1
June	2(100)	NA	NA	2		NA	1(100)	NA	1
July	2(100)	NA	NA	2		1(100)	NA	NA	1
August	3(100)	NA	NA	3		NA	NA	NA	NA
September	2(50)	NA	2(50)	4		1(20)	1(20)	3(60)	5
October	NA	NA	NA	NA		NA	NA	NA	NA
November	NA	1(100)	NA	1		NA	NA	1(100)	1
Total	16(80)	2(10)	2(10)	20		3(23)	3(23)	7(54)	13

Figures in the parentheses are per cent of animals falling in that category.
NA = No animal was found in this category.

TABLE 4

REPRODUCTIVE STATUS OF *Bandicota bengalensis* (GRAY) TRAPPED IN DIFFERENT MONTHS DURING DECEMBER 1970—NOVEMBER 1972

Month	Male				Female			
	Scrotal	Abdominal	Subadult	Total	Perforated	Lactating	Subadult	Total
December	NA	1(100)	NA	1	NA	NA	NA	NA
January	NA	NA	NA	NA	NA	NA	NA	NA
February	NA	1(50)	1(50)	2	NA	NA	NA	NA
March	3(100)	NA	NA	3	2(100)	NA	NA	2
April	3(100)	NA	NA	3	NA	NA	NA	NA
May	NA	NA	1(100)	1	NA	NA	NA	NA
June	NA	NA	1(100)	1	NA	NA	NA	NA
July	4(100)	NA	NA	4	NA	NA	1(100)	1
August	4(100)	NA	NA	4	1(33)	NA	2(67)	3
September	6(100)	NA	NA	6	1(13)	4(50)	3(37)	8
October	NA	NA	1(100)	1	NA	NA	1(100)	1
November	NA	NA	NA	NA	NA	NA	1(100)	1
Total	20(77)	2(8)	4(15)	26	4(25)	4(25)	8(50)	16

Figures in the parentheses are per cent of animals falling in that category.
NA = No animal was found in this category.

throughout the year except during December, January, April and June (Table 2).

Singh (1961) found young ones of this species in fields with their mothers during March to May and again during October to December. Similarly, Prem Sagar & Bindra (1970) reported that the young ones of this rat were found during March to May and again during August to December. The present studies have revealed that this rat breeds throughout the year, although the peak breeding occurred during January to October. Similarly, Jain (1970) reported that *T. indica indica* Hardwicke bred throughout the year but the prevalence of pregnancy reached a peak during the monsoon. Male gerbilles also remained fecund during all seasons.

3. **Golunda ellioti** (Gray). Scrotal rats were present during February-March and during May to September. Unfortunately, owing to low population, no *G. ellioti* was observed during October and December-April. No female was seen during January, August and October. Reproductively active females were predominant during March, July and September. The lactating females were present during April, June and September. Subadults were found during February, May, September, November and December (Table 3). Owing to small number of individuals observed, it is difficult to draw any conclusions, but it appears that the breeding season in this species extends from March to September.

4. **Bandicota bengalensis** (Gray). Owing to a small number of individuals observed, it is difficult to arrive at any conclusion (Table 4). According to Chakraborty (1975) this species breeds throughout the year.

The reduction in or lack of reproductive activity during winter has been reported in other species of rats and mice also (Mann & Bindra 1977, Sadleir 1969, Schiller 1956, Whitaker 1940), and the same has been attributed to short day length or low temperature under which conditions the testes may become abdominal and the spermatogenesis may stop.

Summary

Studies on the reproductive activity were carried out during December 1970 to November 1972 in a grid of 53 ha. cultivated area on the Ludhiana Farm of the Punjab Agricultural University. These revealed that *Rattus meltada* (Gray) and *Tatera indica* (Hardwicke) bred throughout the year except during very cold months, when the reproductive activity was either drastically reduced or absent. In the case of *Golunda ellioti* (Gray) and *Bandicota bengalensis* (Gray), however, it is difficult to draw any conclusion owing to small number of animals observed, but it appears that the breeding season in these species also extends throughout the year with the exception of winter months.

Acknowledgements

We are thankful to the Director, Zoological Survey of India, Calcutta for arranging the identification of the rats.

G. S. MANN
O. S. BINDRA

Department of Entomology,
Punjab Agricultural University,
Ludhiana, Punjab,
January 30, 1978.

REFERENCES

BARNETT, S. A. & ISHWAR PRAKASH (1975): Rodents of Economic Importance in India. Arnold-Heinemann. p. 175.

CHAKRABORTY, S. (1975): Field observations on the biology and ecology of the lesser bandicoot rat, *Bandicota bengalensis* (Gray) in West Bengal. *All India Rodent Seminar, Sidhpur* Sept. 23 to 26, 1975, pp. 102-109.

DAVIS, D. E. (1964): Manual for analysis of rodent population. *The Pennsylvania State Univ., Pennsylvania,* p. 82.

GURAYA, S. S. AND GUPTA, S. S. (1975): Observations on the reproductive biology of the soft furred field-rat (*Millardia meltada*). *All India Rodent Seminar, Sidhpur,* Sept.. 23 to 26, 1975, pp. 70-73.

JAIN, A. P. (1970): Body weight, sex-ratio, age structure and some aspects of reproduction in the Indian gerbil, *Tatera indica indica* Hardwicke in the Rajasthan desert, India. *Mammalia 34* (3): 415-32.

MANN, G. S. & BINDRA, O. S. (1977): Reproductive activity of *Mus* spp. in crop fields at Ludhiana. *J. Bombay nat. Hist. Soc. 74* (1): 162-67.

PREM SAGAR & BINDRA, O. S. (1970): A note on the breeding habits of Indian gerbil, *Tatera indica* (Hardwicke). *Pl. Prot. Bull. 20* (4): 29-31.

SADLEIR, R. M. F. S. (1969): The ecology of reproduction in wild and domestic mammals. Methuen and Co. Ltd., London, p. 321.

SCHILLER, E. L. (1956): Ecology and health of *Rattus* at Nome, Alaska. *J. Mammal. 37*: 181-88.

SINGH, B. (1961): Studies on the biology, habits and control of the field-rat, *Tatera indica* (Hardwicke). *M.Sc. Thesis, Punjab Univ., Chandigarh* (Unpub.)

WHITAKER, W. L. (1940): Some effects of artificial illumination on reproduction in the white-footed mouse, *Peromyscus leucopus noveboracensis. J. exp. Zool. 83*: 33-60.

6. "THE BIRDS OF GOA"

The *Journal* for April 1976 (*73*:42-53) contains a paper "Birds of Goa" which reports on a collection of 150 specimens of 100 species. The total number of species collected and/or seen amounted to 154, which is probably less than half of the species occurring in the area, and there is very little that adds to the information already available.

The following points call for remarks:

1. In the opening section of the Systematic List, the subspecific names are said to be given only for the birds collected and examined, but in some instances this has been done though no specimen is listed, e.g. *Streptopelia orientalis erythrocephala.*

2. There is a general statement to the effect that the subspecies are not likely to be different from those of better worked adjoining areas, but the subspecific name is usually omitted and the specific name used is followed by that of the original author, e.g. *Milvus migrans* (Boddaert). In polytypic species it is not customary to quote the author's name without naming the subspecies; this is particularly confusing in a list in which subspecific names are used. In the instance quoted, the correct name which is *Milvus migrans govinda* Sykes could be well mistaken for the nominate *Milvus migrans migrans* (Boddaert) (type locality France), found in western Pakistan and further westwards, or suggest that no subspecies are admitted.

This irregularity occurs under serial Nos. 1, 2, 3, 5, 6, 8, 10, 13, 16, 18, 19, 20, etc.

3. In the course of cataloguing the Bombay collection, attention has already been drawn to the difficulty/impossibility of separating some of the races upheld in INDIAN HAND-

BOOK. In the present paper, with one or two additional specimens, the same suggestion is repeated in a hesitant manner, with no attempt to come to a definite decision one way or the other.

Among the more specific ambiguities/errors, I can only draw attention to those species which I have had occasion to handle and study in the course of my work.

No. 4 (INDIAN HANDBOOK 130) *Pernis ptilorrhynchus ruficollis* Lesson. The wing of the male (440 mm) is much larger than indicated in INDIAN HANDBOOK (382-417 mm), a fact to which attention has already been drawn (*JBNHS* 65:698).

No. 15 (IH 223) *Falco tinnunculus interstinctus* McClelland. In my Catalogue (*JBNHS* 65(3):723), I have admitted my inability to separate the nominate *tinnunculus* and *interstinctus*. The key in INDIAN HANDBOOK (Vol. 1 : 365) states that adult *interstinctus* is separable from *tinnunculus* by its darker upperparts, but in this paper a bird in subadult plumage is so named as it is "*paler*".

No. 40 (IH 669) *Eurostopodus macrotis* (Vigors). This bird has only been found in the Kottayam, Quilon, and Trivandrum districts in Kerala. Another closely related night bird, the Ceylon Frogmouth (*Batrachostomus moniliger* Blyth) has been recorded in the southwest and as far north as N. Kanara and its call does not appear to have been recorded. Davison in Burma (*Ibis* 1888, pp. 146-7 quoted by Whistler in *JBNHS* 38:39) and Davidson in North Kanara (loc. cit., 12:50) have respectively described the calls of the Great Eared Nightjar and the Frogmouth as 'wailing'. In the present state of our knowledge it would appear unsafe to accept the call as definite evidence of occurrence of this species so far away from its known range.

No. 48 (IH 726) *Alcedo meninting coltarti/rufigaster/phillipsi*. By distribution they are said to be *coltarti* overlooking the fact that specimens from the southwest are accepted as *phillipsi* (Baker, Cocoawatte Estate, Ceylon) and INDIAN HANDBOOK (4:78) has also suggested that this may be the subspecies extending northwards along the Western Ghats.

No. 54 (IH 754) *Coracias garrulus semenowi*. The specimen obtained is in immature plumage. Goa and Karwar (Mysore/Karnataka) are evidently at the southern edge of the regular wave of migration that passes over western India from about August (Khandesh) and Bombay (mid-September to mid-December). I have already (*JBNHS* 70:153) referred to all the four *specimens available from Kutch southwards being in immature plumage, while Meinertzhagen (*Ibis* 1937, p. 50) has found the same to be the case with the birds from Egypt.

No. 73 (IH 924/5) *Hirundo daurica rufula/nipalensis*. The subspecies *rufula* has not been authentically recorded south of the Himalayan foothills and the large flocks that visit peninsular India are presently accepted under the name *nipalensis*. In the absence of any specimen, the suggestion that the subspecies be *rufula* seems to be unjustified.

No. 74 (IH 947) *Lanius schach caniceps* Blyth, Greybacked Shrike. This is referred to as *Rufousbacked*.

No. 82 (IH 973) *Dicrurus h. hottentottus* (Linnaeus). The bill measurements quoted in INDIAN HANDBOOK from Vaurie (1949) are corrected to be 'from feathers' and not 'from skull'. They are actually 'from anterior border of nostril' (loc. cit., p. 280).

HUMAYUN ABDULALI

75, ABDUL REHMAN STREET,
BOMBAY-400 003,
June 15, 1977.

* Also a female from Karnala, Pen, Kolaba on 7th Oct. '72, i.e. 6 in all.

Dr. Sálim Ali comments

I had asked Dr. Grubh, the senior author, to check carefully in the light of Mr. Abdulali's comments and see if and what corrections and alterations were necessary or desirable. To this Dr. Grubh replied that he had gone through the comments and found one error which would be rectified in the next issue of *JBNHS*. This, I understand, is being done.

Subsequently I personally went over Mr. Abdulali's Notes together with Dr. Grubh and found that except for the one error and another slip pointed out by Mr. A. there was nothing of sufficient importance to need specific correcting. The error referred to was in describing a kestrel as the subspecies *Falco t. interstinctus* instead of *F. t. tinnunculus*. In cases where Mr. A. has merely expressed opinions about 'irregularities' etc., he must accept the fact that they are only *his* opinions and not necessarily the last word on the subject!

1. His gratuitous remark that 'there is very little that adds to the information already available' is redundant since it was a factual report of the field survey. If it does not add anything new, as he claims, that is just too bad!

2. In a case where the subspecific name was given although no specimen was procured, e.g. *Streptopelia orientalis erythrocephala*, it was after sufficient familiarity with the species from the Mysore, Bastar and other surveys that I felt perfectly sure of the subspecific identity. However, in this (and similar cases) it would perhaps have been better to enclose the name *erythrocephala* and its author within brackets.

3. Using an author's name after a species name (binomial): This is a matter of individual choice, and there is no sacrosanct rule for or against the practice. Except in systematic publications—as the Goa list must be considered—or where there is fear of ambiguity, the author's name is of course seldom necessary.

4. *Falco tinnunculus interstinctus*: This is an obvious error and is being corrected.

5. Identification of longeared Nightjar by call notes: The calls were heard by Dr. Grubh who drew my attention to them. Being familiar with the very distinctive call and the bird's typical habitat, I have no doubt about the species.

6. Subspecific identification of *Alcedo meninting*: In the Indian HAND-BOOK the subspecies *coltarti* has been admitted for Goa though the validity of this subspecies has been questioned. Mr. A's insinuation here is not understood. As he himself admits (*JBNHS* 64:174) he found it almost impossible to distinguish the races even in the large series in the British Museum. What then did he expect us to decide on a single specimen?

7. Subspecific identification of *Hirundo daurica*: We have referred to the birds as either *rufula* or *nipalensis*. While there is, of course, no reason why even *rufula* may not sometimes be found here in winter, it would perhaps have been better not mentioned considering that it has so far apparently never been identified from peninsular India. Our suggestion was based on the whitish rump and the conspicuously narrowstreaked underparts which are among the diagnostic clues.

8. English name for *Lanius schach caniceps*: In the Goa paper the English name commonly used for species follows THE BOOK OF INDIAN BIRDS.

9. *Dicrurus hottentottus*: Measurement of

bill quoted from Vaurie. A correction from "From Skull" to "From anterior border of nostril" is included in the note sent for publication in the Journal which, moreover, is duly acknowledged to Mr. A. according to his specific stipulation (*JBNHS* 74:357).

27 *August* 1977,
Bombay.

7. PRE-NATAL VOCALIZATION AND IMPRINTING IN BIRDS

For long time, game breeders have known that the eggs of game birds hatch almost simultaneously when incubated by the hen. Game birds like partridge, junglefowl, pheasants and ducks, lay five to twenty eggs. As a rule, only one egg is laid each day and incubation does not start till the clutch is complete. However, due to the fact that these birds breed in summer, preliminary embryonic development of the chick starts by the heat of the atmosphere. Moreover, in order to protect the eggs, the cryptically coloured female starts sitting on the eggs, especially during night. But the female does not cover the eggs completely because the brood patch is not yet fully developed. The brood or incubation patch is an unfeathered area on the ventral side of the body with numerous blood vessels. It is developed to facilitate transfer of body heat to the eggs. By the time all the eggs are layed, the brood patch is completely developed and also gradually increases during brooding. Thus, when actual incubation starts, the first egg is a little more advanced in embryonic development than the last, so that the first egg must normally hatch many hours or even days before the last egg. Howover, we find that all the eggs hatch synchronously when incubated by the mother. On the other hand, if the same clutch is artificially incubated, the eggs hatch one after the other over a period of two or three days. Certainly the explanation of this discrepency lies in the mother hen.

Through ingenious experiments on mallard duck (*Anas platyrhynchos*), Hess (1972) found that the brooding duck vocalizes regularly during the later part of the incubation period. It seems probable that the mallard is answering to the calls produced by the developing ducklings. However, later it was found that the female duck sitting on the infertile eggs calls as much as those sitting on fertile ones. So, the female itself initiates the vocalization. Moreover, it was also found that sitting on the eggs for three weeks or more triggers certain neuro-endocrine mechanisms as the result of which the female starts vocalizing (Hess 1972). Experiments showed that mallards do not respond to the recorded sounds of pre-hatched ducklings during the first and second week of brooding. In fact, during the initial stages of brooding, the response to recorded sound of duckling is threat behaviour. It is only in the third week that the mother responded to the recorded duckling calls with clucking. In the fourth week, all the females experimented with responded favourably with increase in clucking. Therefore, sitting on the eggs for a certain period stimulates the bird — through hormonal action — to start its clucking calls.

Though, the auditory system in embryonic birds develop quite early, structural development does not imply functional development. Grier *et al.* (1967) in chickens found that the ears start responding to exogenous sounds only after 18 days of incubation. Developmental stages of chicken and duckling are very similar. Any sound produced by the mother be-

fore the functional development of the auditory faculties would be useless as far as the eggs are concerned. That is why the mother mallard does not start vocalizing before the third week of incubation. Through countless generations, the vocalizing pattern has become innate and part of the legacy of inherited behaviour. That is why, the duck vocalizes with the infertile eggs even though she does not receive any response from the dead eggs.

Normal fertile eggs respond to the clucking sound of the mother and a sort of 'conversation' starts between the offsprings and the mother. Gottlieb (1965) has shown that several days before hatching, the head of the fetal chick and of the fetal duckling moves into the air space at the large end of the egg. The fetuses of both birds start uttering low-intensity peeps or cheeps. Before and during hatching, vocalization of both the mother and offsprings increases dramatically, as complementary responses.

Synchronous hatching of young ones has great survival value, especially for precocial birds, because if the discrepancy of hatching between the first egg and the last one is long, say of two to three days, the mother would be in a dilemma whether to 'entertain' the new arrival or to brood the remaining eggs. Precocial juveniles might also start scampering around and get lost. In order to minimize the maternal troubles, nature has provided females with a sort of "brood whistle" coordinate the hatching and rearing of the chicks.

The actual mechanism by which the development of eggs is hastened or delayed, as the case may be, is not yet clear. It is probable that the mother utters a particular call—tentatively called here as "hatching call"—for hatching. Fully developed early chicks perhaps delay hatching and wait for the "hatching call" to synchronize their birth with the late developers.

The mother could identify the various stages of embryonic development by the responses she receives from every egg. When she finds that all the eggs are ready for hatching, she may give the hatching call; in this way, synchrony in hatching may be achieved. This hypothesis opens interesting problems for future researches in this field.

Synchronization of the oestrus cycle in man and in animals is well known. Nurses, young nuns and girls living in hostels and dormitories unknowingly synchronize their menstrual cycles. Female dogs housed together invariably come into heat together. This 'menstrual synchrony' is mediated by pheromones. Synchrony in hatching, however, is not mediated by pheromones. This is proved by the fact that when the parent-young vocal responses are transmitted through microphone-loudspeaker hook-up between the female mallard's nest and the laboratory incubators, eggs in the incubators hatch as synchronously as eggs in nature (Hess 1972).

The mallard duck becomes silent as soon as the young are hatched. This silence lasts from 16 to 32 hours until it is time to leave the nest (Hess 1972). Abandoning the nest with the full armada of duckling is termed as "exodus". During the hatching period, which lasts about an hour, the mother generally vocalizes at the rate of from zero to four calls per one minute intervals, except for few bursts when the maximum calls reach up to 10 per minute. However, as the exodus begins, the mallard quickly builds up a crescendo of between 40 to 65 calls per minute.

Pre- and post-natal auditory stimulation thoroughly imprint the offspring to their mother's vocalization (Gottlieb 1965; Grier *et al.* 1967). The young ones might not recog-

nise her by face but her calls remind them of the comforts of the egg, thus they respond positively towards her voice. Intense auditory and tactile interaction occurs after hatching which greatly helps in cementing the filial bond. Hess (1972) found that the ducklings make considerable effort to be near their parent. And the more difficulty they face in getting nearer to the parent, the greater the filial attachment.

By the time exodus begins, ducklings are deeply imprinted towards their mother's call. Moreover, every female vocalizes differently so every duckling easily recognises its mother. Some mallards regularly emit a single cluck at one-second interval, some cluck in triple or quadruple clusters while others cluck in clusters of different lengths. The ducklings remember their maternal call-pattern and simulate them when they themselves nest. In this way call-pattern is transmitted from generation to generation.

One of the interesting findings reported by Bailey & Ralph (1975) in pheasants (*Phasianus colchicus*) is that the chicks show greater affinity for the sound heard during the final week of embryonic development and response to a particular call is learned and not inherited. This is proved by the fact that if tape-recorded alarm call is played back to the eggs during the final days of incubation, the developing chicks associate it with positive reinforcement of comfort within the eggs, and after hatching they do not run and hide when the alarm-call is heard. On the other hand, they would crouch and hide if the food-gathering call is played to them. Any call which they have not heard during their pre-natal days acts as alarm-call for them. Thus, the call that will be attractive to the chick is determined during pre-hatching days and has little dependence on innate responsiveness.

Though the brooding hen might make many sounds the alarm-call is certainly not uttered while sitting on the eggs, because as soon as danger threatens, a cryptically-coloured female of game bird tries to camouflage herself by remaining silent. If the danger is literally on her head, she stealthily skulks away from the nest and when she has gone a considerable distance, she explodes in a cacophony of cackles or quacks to divert the attention of the predator from the nest. (Some birds, like lapwings, killdeer, etc., feign injury and 'guide' the predator towards themselves but fly away at the last moment before being caught.) As the alarm-call or danger signal is not uttered by the female on the nest, the developing young ones are not accustomed to this sound and when they hear this call in post-natal days they run and hide.

As the pheasant chicks grow, their attraction response to a specific call heard during the pre-natal development starts waning (Bailey & Ralph 1975). This stage occurs between 21 and 28 days of post-hatching and coincides with the age at which chicks become independent from the hen in the wild.

ASAD RAFI RAHMANI

DEPARTMENT OF ZOOLOGY,
ALIGARH MUSLIM UNIVERSITY,
ALIGARH 202 001.
October 30, 1979.

Photo 1. Blacknecked Crane in Paddyfield at Begnas, Nepal. (Photo: *Author*)

References

BAILEY, E. D. & RALPH, K. M. (1975): The effects of embryonic exposure to pheasant vocalizations in later call identification of chicks. *Can. J. Zool.* 53: 1028-1034.

GOTTLIEB, G. (1965): Parental auditory sensitivity in chickens and ducks. *Science 147*: 1596-1598.

GRIER, J. B., COUNTER, S. A. & SHEARER, W. H. (1967): Parental auditory imprinting in chickens. ibid. 155: 1692-1693.

HESS, E. H. (1972): "Imprinting" in a Natural Laboratory. *Sci. Amer.* 227: 24-31.

[Sálim Ali (*J. Bombay nat. Hist. Soc. 55*: 166-8) records an instance of post-natal training of a just-hatched Sarus Crane chick at Bharatpur. The chick had emerged two hours earlier from one of a clutch of two eggs. The mother continued to brood the unhatched egg, with the chick unsteadily shuffling about the periphery of the nest. On being alarmed by some movement, the brooding bird hastily got up and was about to move away, when the chick commenced to cheep loudly. The parent gave a subdued *kor-r-r* call when the chick paid no attention and continued to shuffle and cheep took a step back to the nest, repeated the kor-r-r call and pecked the chick gently. The chick reacted instantly, lay down flat and quiet, as the parent moved away.—EDS.]

8. BLACKNECKED CRANE, *GRUS NIGRICOLLIS*, SEEN AT BEGNAS TAL, NEAR POKHARA, NEPAL

(*With a photograph*)

On July 4th this year I was at the Lake Begnas, near Pokhara, Nepal. In the early afternoon I watched a large crane which circled several times over an area of marsh bordering paddyfields at the edge of the lake before it finally landed. I watched it at a range of about ¾ mile though a telescope and was unable to identify it. About two hours later I was able to get much closer and it was clear that the bird was not Sarus, Common or Demoiselle Crane, the only three given in 'Birds of Nepal' by Fleming *et al.* I took a description and later that day identified the bird as a Blacknecked Crane after referring to the FIELD GUIDE TO THE BIRDS OF SOUTH-EAST ASIA by King *et al.*

On July 5th I went back to Begnas with a camera and a borrowed 400 mm. lens. I saw the crane first in two flights, each of about ½ mile, and presumed that despite its general tameness it had been disturbed by the ploughing and planting taking place in the paddy-fields. After it landed the second time I was able to approach it to within 30 yards, photograph it and take a more detailed description.

Later the same morning I saw it again in flight but this time it flew to the hill behind the village of Begnas, picked up a thermal and circled higher and higher until it was lost from view at least one thousand feet up. It was not seen again.

In flight the large size, long neck held straight forward, long wings and long legs projecting well beyond tail, together with the very slow wingbeats identified the bird as a Crane. On the ground this was confirmed by the short, straight bill (about as long as the head) and the drooping black 'tail'. The only direct size comparison was with Whitenecked Stork (*Ciconia episcopus*), and it seemed to stand approximately twice as high as these.

From previous experience of Common Crane (*Grus grus*) I judged that this bird was considerably larger. It was also more heavily built, larger bodied and with noticeably thick legs and thighs.

Generally very tame for a bird of its size.

JOHN ROSSETTI

51, HALSBURY ROAD,
WESTBURY PARK,
BRISTOL, BS6 7ST,
ENGLAND,
November 4, 1978.

9. UNEXPECTED OCCURRENCE OF THE GOLDENBACKED WOODPECKER *DINOPIUM BENGHALENSE* (LINNAEUS) IN KUTCH

On 17th September, 1978 I met with a bird in Vijaya Vilas Plantation (about 8 km. west of Mandvi) which I would least expect to see in Kutch. This was the Goldenbacked Woodpecker. How this bird reached Vijaya Vilas is, at least for me, a mystery and an occurrence which defies any logical explanation. It is a bird that does not migrate, even locally, to distant places as it is not capable of sustained flight over long distances. It can neither fly over the Gulf of Kutch nor over the Little Rann of Kutch adjoining Saurashtra; I am therefore inclined to rule out the possibility of its entering Kutch from there.

Within the last century this woodpecker has not been met with in Kutch, but is listed on page 171 of the BIRDS OF KUTCH (Ali). According to the BIRDS OF SAURASHTRA (Dharmakumarsinhji) the Goldenbacked Woodpecker is found in and around the Gir Forest and Girnar where it is resident. Shri Shivrajkumar Khachar informs me that he has seen it at Hingolgadh (Jasdan). The HANDBOOK (Ali & Ripley) says that the Sind race—*dilutum*—occurs in Baluchistan, Sind and the NW districts of Pakistan; and on this side of the border, in Mt. Abu and parts of west Rajasthan. I have seen it in Sirohi (Rajasthan) in 1968, and it has been recorded from Palanpur and further to the west of it up to Radhanpur taluka[1] which touches the Little Rann. It would be worthwhile if an ornithologist from Pakistan could throw some light on the extent of the present distribution of *Dinopium benghalense* in Sind.

The Kutch area has sprung a few surprises by way of unexpected bird occurrences, among these being the Eastern Whistling Swan, the Woodcock and the Haircrested Drongo; and we now have the Goldenbacked Woodpecker! There are only three ways by which this woodpecker could have landed in Kutch: It may have come flying along in stages from SSW Sind into NW Kutch (Lakhpat Taluka), or the other possible route is from the Banas Kantha District (Radhanpur) of Gujarat into Rapar Taluka of Kutch. However on this route too it would have had to cover considerable distances over the arid portions on both sides of the Rann, plus a narrow strip of the Rann itself. And the third possibility could be that the bird got swept across to

[1] The Birds of Gujarat, *JBNHS* 52: 450, 1954.

this side in a cyclonic storm which blew over the eastern portions of Kutch from the ENE direction about three years ago.

M. K. HIMMATSINHJI

JUBILEE GROUND,
BHUJ, KUTCH,
December 12, 1978.

10. FEEDING BEHAVIOUR OF THE WHITECAPPED RIVER CHAT *CHAIMARRORNIS LEUCOCEPHALA*

This note is based upon observations of a river chat nest at 13,300 feet in the Nanda Devi Sanctuary area of the Garhwal Himalaya, Uttar Pradesh, India. The nest was observed for a period of five days in early August 1977, notes being made of parental behaviour, food items brought, and reactions to any 'strangers' within the territory.

The nest in question was 18 feet above water level in a river cliff cut by the North Rishi Ganga river. The pair's territory extended for 400 metres above, and for 200 metres below, the nest site. The site itself was a ledge, the nest being partially concealed by a veil of grass. The nest was the typical cup shape, made mainly of dry grasses. At the time of observation there were four newly hatched young in the nest.

The river chat is characteristically a very demonstrative bird, calling frequently and usually bobbing and dipping, or 'pumping', as it does so. The pair observed were strongly territorial. Territorial disputes between this pair and another further up the valley took place most mornings as well as on the main days of observation. The closely related redstarts *Phoenicurus* sp. were usually left well alone. Only on one occasion was a male Bluefronted Redstart *Phoenicurus frontalis* chased out of the territory, despite being 300 metres from the nest at the time.

The male and female were not readily distinguishable by plumage, but could be differentiated on the basis of their behaviour, as in the European Robin *Erithacus rubecula* (Lack 1965).[1] The male was the more vociferous of the two birds, calling and singing far more frequently than the female. Any activity in the male was a slow and noisy process, unlike the quicker and less vocal female. The pair were not caught so that it was not possible to definitely assert the correctness of the labelling. Both were distinguished from the juveniles of the year which had a light grey, ill-defined, chest in contrast to the black and sharply defined chest of the adults. Any juveniles coming into the territory were quickly chased out.

Day One. Food items: These were mainly caterpillars or grubs, usually brought one at a time. There was an average of 7-8 minutes between visits by each parent.

The male foraged upstream over a wider area than the female which confined foraging to the sides of the gorge, with occasional visits onto the flats above. The male and female tended to feed synchronously, arriving within 15 seconds of each other. On approach both called, the male frequently on both arrival

[1] LACK, D. (1965): The Life of the Robin. London.

and departure, the female on arrival only.

Day Two. Food items. Grubs, caterpillars, and, on one occasion, a butterfly. Usually a single item per visit. Both birds were still foraging up to 200 metres from the nest. The male averaged one visit per 8 minutes and the female one per 9.

On one occasion a juvenile of the year came onto the river cliff in the absence of both of the birds. Upon return the juvenile was chased out of the territory by the male.

The two birds were distinguished by differing call tones and by different methods of approaching the nest ledge, differences that had first been noted on day one. The male showed a set pattern of nest approach. It flew to within 10-15 metres of the nest, calling as it did so. It then hopped and advanced in increments of 1-2 metres, the call note being an abbreviated 'tsip' version of the full call. Once within 1-2 metres of the nest the bird hesitated, pumped its tail and described a clockwise circle around the ledge. Movements prior to this had involved either a clockwise or zigzag approach. Having spent about 30 seconds on this last procedure the bird then hopped onto the rim of the nest. Here it did not feed straight away but instead stood on the rim, pumped its tail for 10-15 seconds, then fed the young. It then dropped down to an adjacent ledge, moved slowly away from the nest, calling and pumping until about 20 metres from the nest when it flew off up-valley.

The female, in contrast, had a much less elaborate procedure. She approached over the water, calling as she did so, then flew to within 5-6 metres of the nest rim. Once there she fed the young and flew straight away from the nest, uttering at most only a few notes.

Day Three. Food items. Four occasions with two grubs at a visit. On three occasions caterpillars were offered and on a single occasion a winged insect. The average interval between visits was 8 minutes.

The male's approach was the same as that on day two with the slow noisy approach to the rim of the nest. In between two visits a snow pigeon *Columba leuconota* came to roost within 20 metres of the nest. The male was the first back to the cliff and showed distinct signs of agitation. Initially it approached to within 15 metres of the nest then turned around to slowly circle the pigeon. All the time it called loudly and pumped its tail strongly. After about two minutes of this the male ate the food item it had been carrying and departed upstream. By contrast, the female, which arrived three minutes later showed no signs of alarm, went straight to the nest with the usual brief pause and departed having fed the young. On the next and subsequent visits, the male took no notice of the pigeon and resumed its pattern of nest approach.

On one occasion the male was observed to go to within 2 metres of the nest, calling en route as usual. It then did two clockwise circles of the nest ledge lasting $1\frac{1}{2}$ minutes before going to the nest. After a further 30 seconds on the rim the young were fed. This done it retreated slowly to 7 metres from the nest, calling all the time, before it flew off. No noticeable change had occurred in the vicinity of the nest between visits.

The female was again quicker and quieter than the male on approach, with only a few seconds spent on the rim before it fed the young and flew off silently downstream.

Day Four. Food items. One grub or caterpillar at each feeding, with 8-9 minutes in between visits.

The same basic pattern of nest approach was repeated as seen on earlier days. In between visits an adult, carrying food, approached the nest to be quickly chased away by the

returning male.

Day Five. Food items. Two occasions with two grubs, one with a butterfly, but more usually only one grub.

Again several instances of the male getting to within 1 or 2 metres of the nest only to do a clockwise circle or semi-circle before going to the rim of the nest. On one occasion the male got to within $\frac{1}{2}$ metre of the nest before retreating 10 metres and repeating its zig-zag approach with all the usual calls and tail pumping. On no occasion was the female observed to do this.

It is hoped that these short notes may provide a basis for further studies on the feeding of the River Chat.

EDWARD GREY INSTITUTE OF FIELD ORNITHOLOGY,
DEPARTMENT OF ZOOLOGY,
SOUTH PARKS ROAD,
OXFORD, ENGLAND,
March 1, 1978.

TIMOTHY M. REED

11. ROOSTING BEHAVIOUR OF FLOCKS OF THE CRESTED BLACK TIT (*PARUS MELANOLOPHUS*)

Mixed species parties of tits, warblers and other small, insectivorous birds are a familiar feature of Himalayan forests outside the breeding season and similar associations are found among forest insectivores in temperate and tropical regions (Moynihan 1962, Morse 1970). MacDonald and Henderson (1977) have described the composition of these flocks in the Kashmir Himalayas in some detail. The most important species involved in such flocks at altitudes above 2300 m in the upper Beas Valley, Himachal Pradesh in November was the Crested Black Tit, more than 50% of the birds often belonging to this species.

On 11 November 1977 I succeeded in following one mixed species flock from 1630 hrs until dark and was therefore able to observe the process of break-up and roosting for some of the participants, which has not previously been described in detail. The flock was feeding among scattered Deodhars (*Cedrus deodar*) at an altitude of 2400 m near the Solang mountain hut, above Manali. The trees averaged about 30 m in height, with very narrow crowns, and were spaced 10-20 m apart. It was possible for me to follow the flock easily because, despite poor light conditions, the birds were visible in silhouette as they flew from one tree to the next. At 1630 hrs the flock comprised an estimated 83 birds; 65 Crested Black Tits, 5 Green-backed Tits (*Parus monticolus*), 2 White-cheeked Nuthatch (*Sitta leucopsis*), 1 Himalayan Treecreeper (*Certhia himalayana*) and 10 Pallas' Warblers (*Phylloscopus proregulus*).

Between 1630-1700 hrs all species except the Crested Black Tit dropped out of the flock and moved away, presumably to roost solitarily. I continued to follow the tits. Vocalizations increased to a peak at 1700 hrs, most of the calling consisting of the nasal "zee-zee" which is often heard while flocks are feeding. The birds appeared very excited, flitting rapidly from branch to branch, milling about in the topmost branches of one tree and then rapidly crossing to the next in follow my-

leader fashion. At 1705 hrs about 25 birds flew into one tree and within 2-3 minutes became still and silent, apparently perched together about 5 m below the top of the tree. Owing to poor light I could not make out whether they perched in contact with one another, but all must have been within 1 or 2 m. The remainder of the flock distributed themselves in groups of 5-10 in the crowns of neighbouring trees, within 5 m of the top, all being settled by 1715 hrs. Official sunset was at 1710 hrs, but the sun had set well before that behind nearby mountains.

The first group to settle into their roost was preceded by one bird which gave a loud call "tea-cher" repeatedly from the roosting tree for about a minute. A few minutes after the group had entered the roost one bird left the tree and gave the "tea-cher" call briefly from an adjacent tree. One other bird followed it, but the rest remained where they were. There is some suggestion from this that certain birds may play a dominant role in directing the movements of the flock, at least when going to roost.

29 BABAR ROAD,
NEW DELHI 110 001,
December 18, 1978.

A. J. GASTON

REFERENCES

MACDONALD, D. W. & HENDERSON, D. G. (1977): Aspects of the behaviour and ecology of mixed-species bird flocks in Kashmir. *Ibis 119*: 481-493.

MORSE, D. H. (1970): Ecological aspects of some mixed-species foraging flocks of birds. *Ecol. Monogr. 40*: 119-168.

MOYNIHAN, M. (1962): The organization and probable evolution of some mixed-species flocks of neotropical birds. *Smithsonian Misc. Colls. 143*: 1-140.

12. DHAMAN (*PTYAS MUCOSUS*) AND PARAKEETS

In the aviary of this department, 40 parakeets (*Psittacula* sp.) were kept for experimental studies. On 14th August 1979 at 11.30 a.m. when we entered the aviary, we found a heavily fed Dhaman snake (*Ptyas mucosus*) of about 8 feet length. The snake had entered the aviary after 3 p.m. on 13th August, probably through the gap between the doors. The snake had fed so heavily that it was unable to move easily. It was brought to the laboratory and dissected and four parakeets were removed from its stomach.

ENDOCRINOLOGY AND PHYSIOLOGY UNIT,
SCHOOL OF STUDIES IN ZOOLOGY,
VIKRAM UNIVERSITY,
UJJAIN 456 010, (M.P.),
November 5, 1979.

TEJ PRAKSH VYAS
AVADESH K. PANDEY
M. S. PARIHAR

13. A NOTE ON NESTING BEHAVIOUR IN THE INDIAN GHARIAL *GAVIALIS GANGETICUS* (GMELIN) (REPTILIA, CROCODILIA)

Virtually nothing has been published about the natural history of the gharial (Neill 1971). There are no published data on the nesting biology as such, however, Malcolm Smith (1931) stated that the clutch consists of forty or more eggs (a comment which has been extensively copied in the literature in the subsequent half century without addition of new data).

The first eggs of this species known to be captive hatched were collected by the author in 1975 and hatched at the Orissa Gharial Project at Tikerpada in June of that year. The eggs and hatching process was described and illustrated in Bustard (1975, 1976).

Bustard (1976) pointed out that nests are dug in high sand-banks to avoid flooding as a result of water level fluctuations during incubation resulting from melting snow in the Himalayan part of their range, and gave the egg-laying season as April, whereas, Smith 1931, in error, stated that the hatchlings appear in March and April.

During a detailed study on the nesting ecology of the gharial in Narayani river, Nepal, the time of egg-laying was noted in six instances. This occurred at 2200, 2245, 2300 and 2400 (three instances) hours respectively.

In addition, the actual nesting process was also observed from its initiation by me on one occasion. Nesting on this occasion however, did not result in egg-laying. The female was not disturbed. It is not known if it was an instance of trial nesting or the female gave up to try elsewhere, most probably it was trial nesting. The following are extracts from field notes recorded at the time on April 13, 1977, at a distance of 90 m across the river through 6×20 binoculars :

6.34 p.m.	female gharial started to emerge on opposite bank near a track leading to trial nests; early twilight. (The sand-bank had a steeply rising portion, height 2-2.5 m, followed by a flat area and then another steeply rising bank of similar height).
6.35	moved two meters up the steep (45° slope) bank and rested.
6.37	moved up a further 1 m and again rested. The female measures about 3 m.
6.40	moved up 1 m and reached the start of the 'platform' after the first incline.
6.43	moved across platform to foot of next incline (lower here than where the trial nests are), distance 3 m. Moved diagonally towards the other track.
6.45	moved diagonally up the second incline about 3..5 m.
6.47	moved up a further 0.5 m.
6.48	moved about 2 m.
6.49.30 sec.	moving further up the second bank.
6.52	digging commenced as light starting to fail, night fast closing in. Fore limbs exclusively used for digging.
6.55	left front limb actively throwing sand backwards. So far only the front limbs have been used in the excavation, one at a time.
7.02	has not moved, still digging with (only) the front limbs. Now very hard to see (to write even).
7.10	now very dark, still in same position but not possible to observe its actions.

The above field notes indicate a number of points:

1. The slow progression up the steep bank, very reminiscent of the heavier turtles (*Chelonia mydas, Dermochelys coriacea*), hauling ashore to nest, (Bustard 1972, Bustard & Singh 1978). These also move extremely slowly up the beach especially where it is steep. This gharial took 18 minutes to reach

the chosen nesting site near the top of the second bank at a height of about four meters above the water level, and at a distance of approximately 11 metres (in a direct line) from the water, a distance of less than four times its own length. These observations confirm the clumsiness of the adult gharial, one of the most aquatic of crocodilians, and explains their invariable habit when basking of staying very close to the water to which they can return with minimum delay if danger threatens, (Singh & Bustard 1977). The gharial did not climb up the bank, 'hauled out' is the more appropriate term, as with sea turtles.

2. The time of emergence at onset of twilight was exactly the time when the first sea turtles also emerge when the high tide is suitable, (Bustard 1972). Probably most gharial haul out somewhat later under cover of nightfall.

3. The time of egg laying (between 2200 and 2400 hours) probably reflects time taken after nightfall to emerge and prepare the nest. There may, however, be selection towards nesting later in the night since this may tend to reduce predation. Foote (1978) noticed a similar phenomenon in *Podocnemis* a large freshwater turtle of the Amazon.

4. All the observed digging was done by the fore-limbs, and these did not work together but separately; that is, a number of excavations were made by one fore-limb, then after a rest period the other fore-limb carried out digging activities. However, it is assumed that the final nest construction is carried out by the hind limbs, which, as in the case of turtles, would appear much better suited (shaped) for handling this task. This procedure is analogous to the process which is followed in sea turtles. The preliminary excavation is carried out by the fore-limbs which clear the area of dry surface sand exposing the firmer, usually moister, substrate in which the egg pit is dug exclusively by the rear flippers (Bustard 1972). The digging observed above is, therefore, assumed to be preliminary to the main excavation.

It is probable, however, that trial nesting is carried out using the fore-limbs.

The above observations are recorded since so little has been reported on nest excavation in any crocodilian species and because it is generally stated or assumed that only the rear limbs are used in nest excavation, see for instance Neill (1971) for the American alligator.

H. R. BUSTARD

CENTRAL CROCODILE BREEDING AND MANAGEMENT TRAINING INSTITUTE,
LAKE DALE, HYDERABAD 500 264,
INDIA,
September 12, 1979.

REFERENCES

BUSTARD, H. R. (1972): Sea Turtles: Natural History and Conservation. Collins, London and Sydney.

——————— (1975): A future for the Gharial. *Cheetal, 17* (2): 3-8.

——————— (1976): Operation Gharial. *Cheetal 17* (3/4): 3-6.

——————— & SINGH, L. A. K. (1978): Studies on the Indian Gharial *Gavialis gangeticus* (Gmelin) (Reptilia, Crocodilia). Change in terrestrial Locomotory Pattern with Age. *J. Bombay nat. Hist. Soc., 74* (3): 534-536.

FOOTE, R. W. (1978): Nesting of *Podocnemis inifilis* (Testudines: Pelomedusidae) in the Colombian Amazon. *Herpetologica, 34* (4): 333-339.

NEILL, W. T. (1971): The Last of the Ruling Reptiles: Alligators, Crocodiles and their Kin. Columbia University Press, New York and London.

SMITH, MALCOLM, A. (1931): The Fauna of British India including Ceylon and Burma. Reptilia and Amphibia. Vol. I. Loricata, Testudines. Taylor & Francis, London.

SINGH, L. A. K. & BUSTARD, H. R. (1977): Studies on the Indian Gharial *Gavialis gangeticus* (Gmelin) (Reptilia, Crocodilia) III: Locomotory Behaviour during Basking and Spoor Formation. *British J. Herpetol.* 5: 673-676.

14. SOME OBSERVATIONS ON THE COMMON HOUSE GECKO (*HEMIDACTYLUS FRENATUS*) OF SOUTHERN INDIA

INTRODUCTION

Studies on the food and feeding habits in Indian lacertilian species are few and relate only to *Calotes versicolor* (Dave 1960, Indurkar & Sabnis 1976), *Mabuya dissimilis* (Dave 1960), *Ophiomorus tridactylus* (Rathor 1969), *Varanus bengalensis* (Minton 1960), *Hemidoctylus flaviviridis* (Parshad 1916), and *Hemidactylus brooki* (Laximinarayana *et al.* 1975). One of the commonest house gecko in South India is *Hemidactylus frenatus*. Although they are very common yet very little is known about their dietary, reproductive and social behaviour. Data were collected on food, feeding habit, home-range and courtship behaviour of the South Indian house gecko, which is being presented.

MATERIALS AND METHODS

The present report is based on observations on lizard *Hemidactylus frenatus,* resident in some lodges of Bandipur National Park, Mysore. The lizards were collected in the study area by hand. They were marked and sexed. A number was painted on the back of each lizard with black paint. This was visible at a good distance but each lizard was recaptured and repainted after its shedding. The lizards after their capture were released within 3-5 minutes—in the area where they were caught. The lizards released after their marking were found to be nervous for 30-60 minutes before they resumed their normal activities. The sexing of individuals was done by pressing the vent region with the thumb. In males, hemipenis comes out under mild pressure while in females a milky liquid oozes out. The total number of lizards in the study area were 14 (5 ♂♂, 7 ♀♀ and 2 juveniles). The study period extended from 10th of January, 1978 to 15 of March, 1978, which incidentally coincides with the breeding period of the lizard. The largest male and female were measured (see Table) to assess size relation if any, to sexual dimorphism which was not noted. The adult males and females did not show any striking colour pattern differences while the juveniles were recorded to have darker dorsum than the adults. Moreover, two rows of interrupted longitudinal bands were quite distinct dorsally that are not sharp and seem to fade out with maturity.

TABLE

Measurements (mm)	Male	Female
Total body length	127	124
Snout vent length	65	63
Tail length	62	61

Feeding Habits

These house geckoes are nocturnal in habit and feed from dusk to midnight, although occasionally, some were seen feeding during daytime as well. During daytime, they generally hide in crevices, behind tube lights or some other such retreats. The diurnal retreats are regularly occupied. Around dusk, they begin to move about and were seen to be most active between 20-24 hrs. Past midnight their activity declines. At night, they were often attracted by lights, which provided them incidental feeding grounds. During the morning hours, they were often found basking on the outer walls and ledges of the lodges. Twice (on 17-ii-1978 at 11.30 a.m. and on 2-iii-1978 at 2 p.m.), a house gecko was observed to come out of its hiding to lap up a few drops of water in a bathroom.

The insects hovering at lamps are approached and caught directly but in the case of still insects, the lizards reach to about its flight distance and stop, bob their heads and flick the tongue. If the insects move towards the lizards and are within capturing distance, the lizards grab them. Large insects are usually preferred. Should the prey happen to be a large meal, then after the capture, it is violently shaken by jerky movements of head and then hammered against the surface till it is motionless and ceases to make any attempt to escape. During the ground feeding, the insects are often released and recaptured.

Though the diet was found to be varied, certain families and orders of insects such as hemipterans, hymenopterans (except winged ants)and some coleopteran families (Cantharoidae, Hydrophilidae) are left alone. The dipterans (flies and mosquitoes), orthopterans (grasshoppers, cockroaches and mantids), homopterans (leaf hoppers) and lepidopterans (moths and butterflies) are preferred.

Home-range

Tinkle (1967) defined home-range as an area occupied by an animal and utilized in its search for food, for mates, and for shelter. These lizards are also found to preserve their territorial rights particularly during the breeding season as indicated by the instance of 7th February when a resident male was found to chase an intruder male out of its territory. The resident male at that time was seen to possess one female. Generally one male and one female were seen together but occasionally two females were also sighted with one male. The home-range was found to be determined by the availability of food and egg laying sites. In places where the lamps were regularly lighted and crevices or holes were available near by, the lizards used to confine themselves to restricted areas; on the other hand where the lamps were not in regular use and hiding places were far off from the lamps, they used to wander in much larger areas. The home-range varies from 2 sq. m to 6.5 sq. m. The calling of the male's *chuck-chuck* can be heard at any time irrespective of any hour of the day or night. But these calls were more frequent during the night between 21-25 hrs. These calls were so loud that they could be heard at a distance of 10-15 metres. Four marked males caught from distant places were introduced in the resident male area (2 on 30th January, and 2 on 4th February). These introduced males were found to take no part in feeding and remained 1-2 metre apart from the resident male for 2 to 30 hrs and subsequently they were not sighted in the area. The first introduced pair was seen to be driven away by the resident male within 2 hrs of their introduction, while the second pair was seen there up to 30 hrs, after that period they were

not traceable, probably driven away from the area. On 15th March, a juvenile was seen in the area of resident male, who after sighting it, started calling *chuck-chuck* which was responded to by the intruder by moving away from the site.

Courtship and Mating

On 9th February at 21.15 hrs copulation was noticed in a pair of lizards. The male after seeing the female, moved slowly towards it, and stopped at half a metre distance for 40 seconds. The male bobbed his head and flickered his tongue, and slowly approached the female. It made three continuous calls *chuck-chuck-chuck*. He made half a circle so as to come to the left side of the female. The female did not move and male nodded its head and licked her snout. The male moved and lay parallel to the female. The female now responded by raising her tail in an arc. The male moved towards the right and hinder part of the female so as to bring the cloaca opposite to that of the female. The tail of the male passed under the female's tail and coiled around it. The male clasped the female with both pairs of limbs. The copulation lasted for $8\frac{1}{2}$ minutes when female began to slide down from underneath. Prashad (1916) recorded copulation time 4 minutes and McCann (1940), 10 minutes in case of *Hemidactylus flaviviridis*. The male was found to lick her vent after copulation. Both the partners were rested thereafter. During copulation they are not disturbed by the presence of the observer even when about a metre from them.

Acknowledgements

I am extremely grateful to Dr. P. L. Duda for critically going through the manuscript and for useful suggestions. Thanks are due to Prof. Madhav Gadgil and A. J. T. Johnsingh, Indian Institute of Science, Bangalore for suggesting the problem during the training course in Wildlife Biology conducted at Bandipur National Park, Mysore.

DEEP SAHI

Dept. of Bio-sciences,
University of Jammu,
Jammu-180 001,
August 3, 1978.

References

Dave, K. C. (1961): Contribution to the systematics and distribution of the reptiles of the desert of Rajasthan with reference to the ecology of lizard. Doctoral thesis, University of Rajasthan, Jaipur, India.

Indurkar, S. S. & Sabnis, J. H. (1975): Observations on the dietary components of the garden lizard, *Calotes versicolor* (Daud.). *Comp. Physiol. Ecol.* Vol. 1, No. 1 pp. 9-12.

Laximinarayana, A. *et al.* (1975): Food and feeding habit of common wall lizard *Hemidactylus brooki* Gray. *Curr. Res.* 1975 (4): 82-83.

McCann, Charles (1940): A reptile and Amphibian miscellany. *J. Bombay nat. Hist. Soc.* 41, No. 4, pp. 742-764.

Minton, S. A. (1966): A contribution to the herpetology of West Pakistan. *Bull. Amer. Mus. Nat. Hist.* 134 (2): 27-184.

Parshad, B. (1916): Some observations on a common house lizard (*Hemidactylus flaviviridis*) of India. *J. Bombay nat. Hist. Soc. 24*: 834-838.

Rathor, M. S (1969): Food and feeding habits of Indian Sand skink, *Ophiomorus tridactylus* (Blyth) Boulenger. *J. Bombay nat. Hist. Soc.* 66: 186-190.

Tinkle, D. W. (!1967): The life and demography of side bloched lizard, *Uta stanburiana. Miscellaeneous Pub. Mus. of Zool. Ann. Arbor, Michigan, U.S.A.*

15. RECORD OF THE ROCK-LIZARD, *PSAMMOPHILUS BLANFORDANUS* (STOLICZKA) (SAURIA: AGAMIDAE) IN ARAKU VALLEY, EASTERN GHATS (ANDHRA PRADESH), INDIA

In the course of extensive faunistic investigations carried out by the junior author from March through April 1979, two agamid lizards were picked up from the rocks in Araku forest situated at an elevation of 1000 m. The time of capture was 14.00 hr. Of the two specimens in the series, the larger (89 + 192 mm) is a male and the smaller (65 + 135 mm) is female.

The junior author saw several pairs of this lizard on rocks and bushes in Araku forest and noted that the head and fore-part of the males were scarlet-red in colour indicating that they were breeding males.

We are grateful to the Director, Zoological Survey of India, Calcutta for encouragement and the Officer-in-Charge, Southern Regional Station, Madras for necessary facilities.

ZOOLOGICAL SURVEY OF INDIA,
100 SANTHOME HIGH ROAD,
MADRAS 600 028, INDIA,
August 8, 1979.

T. S. N. MURTHY
T. VENKATESWARLU

16. A NOTE ON THE DISTRIBUTION OF *BARKUDIA INSULARIS* ANNANDALE, A RARE LIMBLESS LIZARD FROM ORISSA

The limbless lizard, *Barkudia insularis* Annandale, was originally reported by Annandale (1917) on a single specimen dug up by Gravely from loose earth at the root of a banyan tree at Barkuda Island in Chilka Lake, Orissa in July, 1916. Later in the rainy season of 1919 Gravely sighted (Annandale 1927) another specimen in the same locality and attempted to catch it but failed due to the rapidity with which the skink burrowed into the earth among the roots of a fig-tree, only the tail remaining in the hands of Dr. Gravely. A third specimen was obtained from the same locality by O. B. Chhotani of the Zoological Survey of India. For a long time the species was believed to be confined to Barkuda island, till Dr. P. N. Ganapati, Professor of Zoology, Andhra University, recorded the species from the Andhra University Campus at Waltair in 1952 (Ganapati & Krishnan 1952). A recent find of this skink from the Nandankanan Biological Park, 15 km. north east of Bhubaneshwar in Orissa, however, shows that the species may have much wider distribution than hitherto known.

In all four specimens were collected from this locality by one of us (LNA), two on 2-11-1973, one on 15-8-78 and the fourth on 7-9-78. The first two, one of which was collected from below the mud of an almost dry tank, were examined and measured.

The limbless lizard, like uropeltid snakes, is a burrowing form and presumably nocturnal in habit. This may account for the rare frequency of its collection. According to Gravely it is a very fast burrower and thus hard

to catch. Because of its burrowing habits it may not be easily seen during dry season when the individuals may go deeper in the burrow and not come up frequently. Most of the specimens of this species were collected (or spotted) near about during the rainy season when the burrows get frequently inundated compelling the lizards to come up.

From the records of the species it appears that this is distributed along the coastal belt in Orissa and Andhra Pradesh.

The type collection on which Annandale (1917) based the description of the this genus seems to have been lost in the Varuna flood in 1943 when the Zoological Survey of India was temporarily shifted to Varanasi.

Material examined: 2 examples; Reg. No. 23659; Loc: Nandankanan Biological Park, Barang, Dist. Cuttack, Orissa; Coll.: L. N. Acharjyo; date: 2-11-1973.

Measurements: Snout to vent 12.5 mm, Tail 7.5 mm, Breadth 6.7 mm. and Snout to vent 15 mm, Tail 8.7 mm, Breadth 7.7 mm.

The blunt snout (dorsoventrally flattened) and tail (rounded at the tip) have earned the name "DEEMUNDIA" (two-headed) to this lizard locally in Orissa. It is cream-coloured with six prominent dorsal, broken up lines, between the back of head and tip of tail. Similar, but faint, spotted lines are present on the flank on both sides. The head and terminal 30 mm. of the tail tip are brown in one specimen; in the other only the head is brown and the six longitudinal spotted lines are continued upto the tip of the tail. Underside in both is cream coloured.

SUPERINTENDING ZOOLOGIST,
ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA-700 016.

S. BISWAS

VETERINARY SURGEON,
NANDAN KANAN BIOLOGICAL PARK,
BARANG, DIST. CUTTACK, ORISSA,
December 28, 1979.

L. N. ACHARJYO

REFERENCES

ANNANDALE, N. (1917): A new genus of limbless skinks from an island in the Chilka Lake. *Rec. Ind. Mus. 13*: 17-21.

——————— (1921): The Reptiles and Batrachia of Barkuda. *Rec. Ind. Mus. 22*: (4): 331-333.

GANAPATI, P. N. (1952): Occurence of limbless lizard belonging to the genus *Barkudia* Annandale in the Andhra University Campus. *Current Science 21*: 105-106.

——————— (1955): Bionomics and some anatomical peculiarities of the limbless lizard *Barkudia insularis* Annandale. *Rec. of Ind. Mus. 52*: (1 & 2): 279.

17. COMMENTS ON THE FIRST RECORD OF *BOTIA* (PISCES: COBITIDAE) FROM THE WESTERN GHATS BY RAO & YAZDANI

(*With a text-figure*)

The only species of *Botia* we had come across in Maharashtra State was the striped loach, *Botia striata kolhapurensis*. *Botia striata* was first described by Rao (1920) from the river Thunga, Shimoga town in Karnataka State. Kulkarni (1951) reported the

extension of its range to Kolhapur, and Kalawar & Kelkar (1956) created a new subspecies, *B. striata kolhapurensis* for the specimens collected from this region.

From the photograph of the fish, identified by Rao & Yazdani (1977) as *Botia dayi*, we could surmise that in appearance it closely resembled *B. striata kolhapurensis*. However, in the absence of an opportunity to examine the actual specimen collected by them, this could not be definitely ascertained. In August 1979, we had the opportunity to examine the specimen in detail, while on loan from the Zoological Survey of India to the Curator, Taraporevala Aquarium. Our suspicion that it was *B. striata kolhapurensis* was at once confirmed.

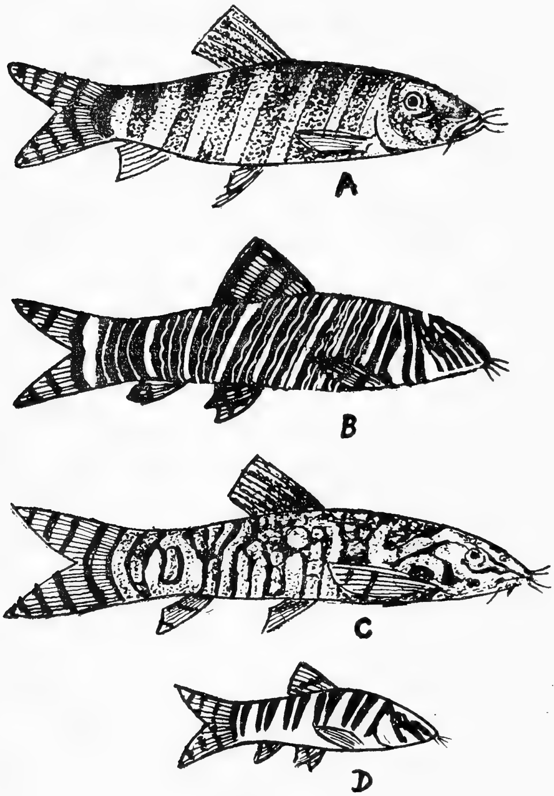


Fig. 1

A. *Botia dario;* B. *Botia striata kolhapurensis* (adult); C. *Botia dayi;* D. *Botia striata koplhapurensis* (juvenile).

Botia dayi has had a chequered taxonomic history. Buchanan (1822) described a new species of loach from northern Bengal and named it *Cobitis geto*. Gunther (1868) was of the opinion that it was a juvenile stage of *Botia dario* (H.B.)—a closely allied species. Day (1872) considered it as a doubtful synonym of *B. dario*. Hora (1922) considered the two as different species but subsequently, in 1932, he revised his opinion, considering it to be a young stage of *B. dario*. He raised Day's (1878) *Botia geto* from Sind to the status of a new species, naming it *Botia dayi*. Menon (1974) considered *B. dayi* Hora to be a synoym of *Botia rostrata* Gunther.

Rao & Yazdani (1977) have not described the morphological characters of their *Botia dayi*, stating only that their specimen agrees well with the description given by Hora. While Day (1878) used morphological characters, such as the number of rays on the various fins and the numbers of barbels, Hora considered the taxonomy of Indian species of *Botia* to be unsatisfactory and gave a key in which the prominent distinguishing characters were morphometric, being based mainly on the proportions of the various parts of the body and position of eyes. From his key *B. striata* can be distinguished as having its eyes almost in the posterior half of the head, whereas *B. dayi* (*B. geto* in his 1922 key) does not have the eyes situated wholly in the posterior half of the head. The fin-ray counts of the two species are as follows:—

Botia dayi (as given by Hora): D. 2/9; V. 1/6; P. 2/11-12; A. 2/5.

Botia striata (as given by C. R. N. Rao): D. 2/9-10; V. 8; P. 13-14; A. 1/6-7.

Botia striata kolhapurensis (as given by Kala-

war & Kelkar): D. 2/9; V. 1/7; 2/9-10; A. 2/5.

Kalawar & Kelkar (op. cit.) have separated the subspecies *kolhapurensis* from the species (*s.s.*) partly because of its different colour pattern; while the stripes on the body in *B. striata* meet in the mid-ventral line, in the subspecies *kolhapurensis* they stop short latero-ventrally. It may, however, be stated here that we, in the course of examination of hundreds of specimens of *B. striata kolhapurensis,* find two colour variations. In some specimens (mostly those which are lightly coloured) these stripes fail to meet in the mid-ventral line, but in other (darker) specimens, posterior to the anal fin they do meet mid-ventrally, although in the anterior portion of the body they stop short on the sides.

Juvenile specimens of *B. striata kolhapurensis* have a few broad black bands on the body. As they grow, each broad band splits up into (usually) three narrow stripes, until they reach the final body coloration of the adult with numerous narrow stripes. In the juvenile stage, therefore, *B. striata kolhapurensis* may be confused, on a cursory look, with *B. dario,* which too has a similar colour pattern of oblique dark bands. *B. dayi,* on the contrary, has a characteristic coloration, the body being reticulated with dark bands which anastomose with one another and enclose yellowish spots of different sizes.

Rao & Yazdani have apparently overlooked, the earlier reports of Kulkarni, and of Kalawar & Kelkar. Even had their specimen been really *B. dayi,* it was not the first record of the occurrence of the cobitid genus *Botia* in the Western Ghats, as stated in the opening sentence of their note. Annandale (1919) as well as Silas (1953, 1954) did not record any *Botia* from Mahableshwar, Wai, and elsewhere in the Western Ghats, but the records by Kulkarni, and by Kalawar & Kelkar do not leave any doubt about the validity of their identification.

To summarize, the specimen of *Botia* mentioned by Rao & Yazdani (op. cit.) is not *B. dayi* but *B. striata kolhapurensis.* Secondly it is not the first record of the genus *Botia* from the Western Ghats.

ACKNOWLEDGEMENT

We are grateful to Shri J. N. Pande, Curator, Taraporevala Aquarium, Bombay for allowing us to examine Rao & Yazdani's specimen while on loan from the Zoological Survey of India.

B. F. CHHAPGAR

E-31, CUSROW BAUG,
SHAHID BHAGATSINGH ROAD,
BOMBAY-400 039.

S. R. SANE

SACHETAN,
L/4-5, SITARAM BUILDING,
PALTON ROAD,
BOMBAY-400 001,
August 28, 1979.

REFERENCES

ANNANDALE, N. (1919): The fauna of certain small streams in the Bombay Presidency. V. Notes on freshwater fishes mostly from Satara and Poona Districts. *Rec. Ind. Mus. 16*: 125-138.

BUCHANAN, H. (1822): Fish. Ganges: 354, 355.

DAY, F. (1872): Monograph of Indian Cyprinidae. Part V. *Journ. As. Soc. Bengal 41*: 177.

——— (1878-88): The Fishes of India *1*: 606; *2*: pl. 154.

——— (1889): The fauna of British India, including Ceylon and Burma; Fish *1*: 216.

GUNTHER (1868): Cat. Fish Brit. Mus. *7*: 366, 367.

HORA, S. L. (1922): Notes on fishes in the Indian Museum. IV. On fishes belonging to the genus *Botia* (Cobitidae). *Rec. Ind. Mus. 24*: 313-321, 1 fig.

——— (1932): ibid. XIX. On a new loach of genus *Botia*, with remarks on *Botia dario* (Ham-Buch.). ibid. *34*: 571-573.

KALAWAR, A. G. & KELKAR, C. N. (1956): Fishes of Kolhapur. *J. Bombay nat. Hist. Soc. 53*: 669-679, 3 figs.

KULKARNI, C. V. (1951): Some significant records of fish from Kolhapur, northern section of Western Ghats. *Curr. Sci. 20*: 334, 335.

MENON, A. G. K. (1974): A check-list of fishes of the Himalayan and the Indo-Gangetic plains. *Inland Fish. Soc. India, Special Bulletin 1*: 1-136.

RAO, C. R. NARAYAN (1920): Some new species of Cyprinoid fish from Mysore. *Ann. Mag. nat. Hist.* (9) *6*: 45-64, pl. ii, figs. 4, 4*a*, 4*b*.

RAO, M. BABU & YAZDANI, G. M. (1977): Occurrence of cobitid genus *Botia* Gray in the Western Ghats of India. *J. Bombay nat. Hist. Soc. 74* (2): 367, 368, 1 photograph.

SILAS, E. G. (1953): Notes on fishes from Mahableshwar and Wai (Satara District, Bombay State). ibid. *51*: 579-589, 1 pl., 4 figs.

——— (1954): New fishes from the Western Ghats, with notes on *Puntius arulius* (Jerdon). *Rec. Ind. Mus. 51*: 27-37, 1 pl., 4 figs.

18. AN INTERESTING METHOD OF FISHING IN BASTAR DISTRICT, MADHYA PRADESH

(*With a text-figure*)

In the course of a fish survey of Bastar District in 1978, we came across an interesting method of fishing in the River Narangi, a tributary of River Indrawati, near Kondagaon. The method essentially consists of a cast net modified to act as an under-water trap, together with a device for directing fishes towards the net. In summer the water level in the river Narangi is very low and several water pools are formed in its entire course. As the fish population is poor in these pools, a cast net is not effective. The local fishermen have, therefore, developed a system by which they obtain a fairly good catch is shallow waters, between 2 and 3 metres depth, with the aid of cast net in a modified form.

The following articles are used in this method of fishing: one cast net (mesh size $\frac{1}{2}$ cm), one float [dried shell of gourd (*Lagenaria siceraria*) known as 'tumba'] fixed at the narrow end of the net, two cords of coconut fibre, three bamboo poles about two metres long, and leaves of "chhind" (*Phoenix pusilla*—Family Palmae) tied to the cords at intervals of about 10 cm. The cord with leaves tied to it is locally called "*bela*".

The cast net is stretched under-water in a conical shape, rather like a bell (Fig. 1). The open mouth of the net is attached to two poles

(Nos. 1 & 2) fixed vertically under water at a distance of about $1\frac{1}{2}$ metres from each other. The narrow, closed end of the net is tied to a float which maintains its shape. A third pole (No. 3) is also fixed at a distance of a metre from pole No. 2. A *bela* measuring about 1 metre is tied between it and the pole No. 2. Another long *bela* is tied to the pole No. 1 and drawn underwater by a fisherman towards the pole No. 3 while encircling a large area of water. During this operation, fishes are scared on seeing the moving *bela* and the light reflected by the *Chhind* leaves. As the fixed *bela* between pole No. 2 and 3 also acts as a barrier, all the fishes while trying to escape the supposed danger enter the cast net and get trapped.

Fishermen lift the net up as soon as the end of the long *bela* reaches pole No. 3. The whole operation takes nearly half an hour and both pelagic and benthic forms are caught.

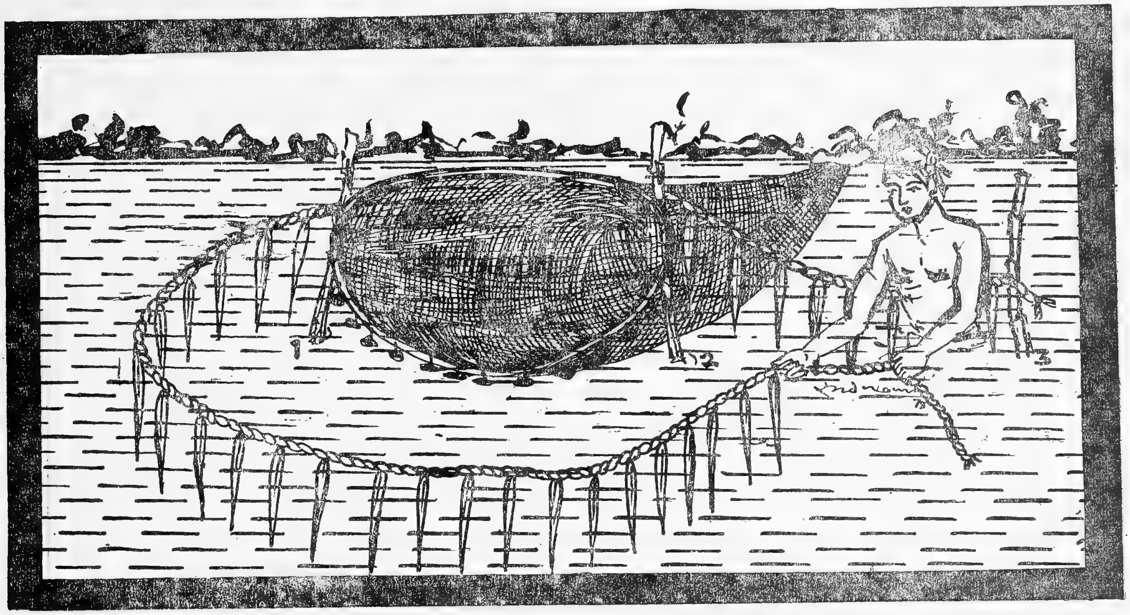


Fig. 1. The underwater trap net in operation.

We are grateful to Dr. K. Reddiah, Deputy Director and Officer-in-charge of this Station for giving us an opportunity to survey the Bastar Distt. (M.P.)

ZOOLOGICAL SURVEY OF INDIA,
CENTRAL REGIONAL STATION, JABALPUR,
March 3, 1979.

G. M. YAZDANI
D. K. HARSHEY

19. ON A COLLECTION OF FISH FROM RIVER KOSI (BIHAR)

(*With a text-figure*)

INTRODUCTION

The river Kosi system which plays a vital role in the development of fisheries in Bihar and constitutes one of the main natural source of fish seed (spawn), much needed throughout the country for culture of fast growing fishes, has not so far been fully exploited. During the course of investigations in 1965 and 1966, to locate new fish seed sources in two *dhars* of river Kosi—the Kosi-khanua and the khagna, large number of young fishes were collected to ascertain the natural distribution of freshwater fishes. This paper deals with the topography and fish fauna of both the *dhars* and a stretch of river Kosi extending from the confluence of the Kosi-khanua *dhar* to the origin of river khagna.

The river Kosi, one of the main tributaries of the river Ganga drains the southern slopes of the Himalayas between 26° N to 30° N latitude and 85° to 90° E longitude, is formed by the union of three important rivers—Sunkosi, Arun and Tamur, taking their origin near Kathmandu, Tibet, and the north east hills of Kanchenjunga respectively. These three rivers join together at Tribeni to form Saptkosi which flows through a gorge and debouches into the plain near Chatra. Lower down Chatra, the Kosi (as it is called) flows for

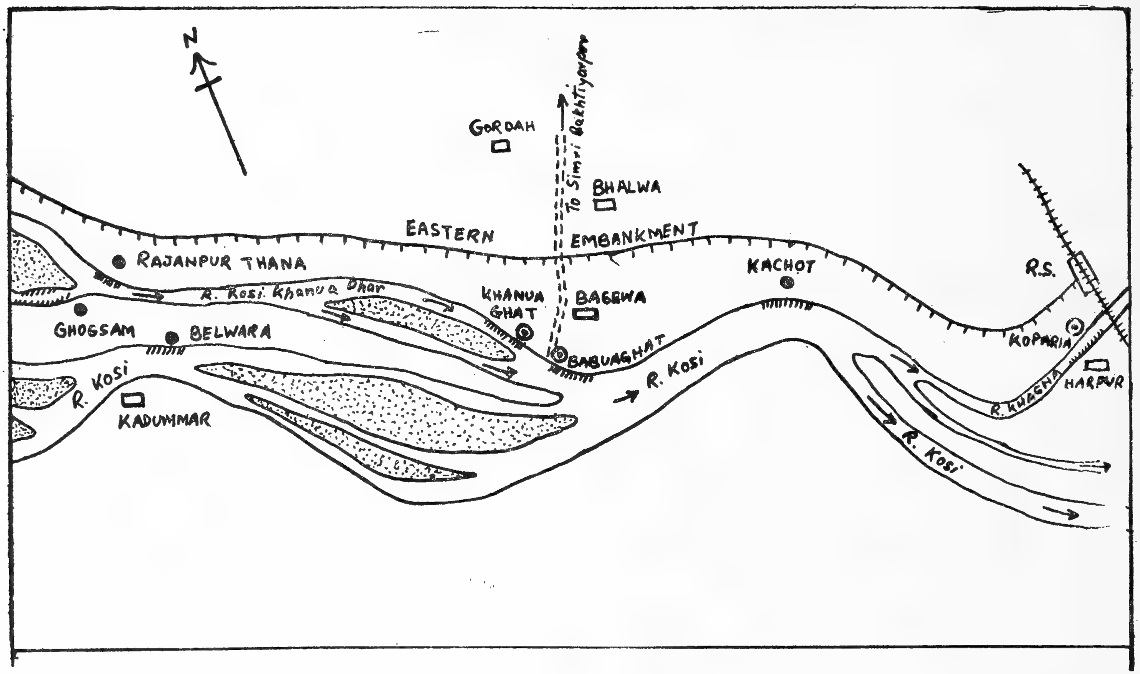


Fig. 1. Babuaghat stretch of Kosi khanua *dhar* and Koparia stretch of Khagna, showing sites prospected and centres investigated.

about 318 km in an alluvial plain to meet the river Ganga near Kursela. The river Kosi is well known for its profuse branching into many *dhars* and for changing its course. It may be mentioned that in the early part of the 18th century the Kosi flowed below the town of Purnea but it has gradually worked westwards across 120 km of the country as is evidenced by its deserted channels (Chhibber 1949).

Reports on fish collection from the Kosi river system are scanty and none from the Kosi-khanua and the Khagana. Menon (1949) reported 52 species of fish from the Kosi in Nepal territory and particularly from regions above and below the proposed dam site at Barahkshetra. Further, in 1954 and 1962 he described the fish fauna from the Kosi drainage of the eastern Himalayas and discussed zoogeographical significance of their distribution. David (1959) gave an account of fish seed collection centres from Kosi *dhars* near Supaul and suggested *dhars* as probable breeding grounds of major carps of India. DeWitt (1960) reported fishes from the Kosi system of Nepal. Menon (1962) gave a distributional list of all known species of fishes from the definite drainage systems in the Himalayas and recorded 69 species from the Kosi drainage. While describing distribution of the genus *Garra*, Menon (1964) recorded three species *Garra lamta, Garra gotyla* and *Garra annandalei* from this system.

During spawn prospecting investigations, in the Kosi-khauna at Babuaghat and the Khagna at Koparia, considerable number of juveniles of various species of fish were collected from spawn collection nets and further collections were made by operating cast nets. Babuaghat, which is situated on the eastern bank of Kosi-khaua *dhar* at about 3 km upstream of the confluence with the Kosi, lies in district Saharsa about 12 km from the town of Simri Bakhtyarpur. Koparia, another main collection centre, is located on the eastern bank of the Khagna about 10 km downstream from Babuaghat (Fig. 1). The river Khagna which has its origin from main Kosi at Kachot village, remains a deserted channel for a greater part of the year and becomes filled with water from the Kosi only during monsoon.

Systematic list

108 species of fishes belonging to 26 families have been reported from the Kosi drainage. Of these, 62 species marked with an asterisk (*) are recorded for the first time during the present investigation from the middle reaches of the Kosi system.

Family: Clupeidae

*1. *Gadusia chapra* (Hamilton)

Family: Engraulidae

*2. *Setipinna phasa* (Hamilton)

Family: Notopteridae

*3. *Notopterus notopterus* (Pallas)

Family: Cyprinidae

*4. *Chela laubuca* (Hamilton)
5. *Oxygaster argentea* (Day)
*6. *Oxygaster bacaila* (Hamilton)
*7. *Oxygaster gora* (Hamilton)
*8. *Oxygaster phulo* (Hamilton)
*9. *Barilius barila* (Hamilton)
10. *Barilius barna* (Hamilton)
11. *Barilius bendelisis* (Hamilton)
12. *Barilius shacra* (Hamilton)
13. *Barilius vagra* (Hamilton)
14. *Danio (Danio) aequipinnatus* (McClelland)
15. *Danio (Danio) dangila* (Hamilton)
16. *Danio (Danio) devario* (Hamilton)
17. *Rasbora daniconius* (Hamilton)
*18. *Amblypharyngodon mola* (Hamilton)
19. *Aspidoparia jaya* (Hamilton)
*20. *Aspidoparia morar* (Hamilton)
21. *Chagunius chagunio* (Hamilton)
*22. *Puntius chilinoides* (McClelland)
23. *Puntius chola* (Hamlton)

24. *Puntius clavatus* (McClelland)
*25. *Puntius conchonius* (Hamilton)
26. *Puntius gelius* (Hamilton)
*27. *Puntius sarana* (Hamilton)
*28. *Puntius sophore* (Hamilton)
*29. *Puntius ticto* (Hamilton)
30. *Lissocheilus hexagonolepis* McClelland.
31. *Tor putitora* (Hamilton)
*32. *Catla catla* (Hamilton)
*33. *Cirrhinus mrigala* (Hamilton)
*34. *Cirrhinus reba* (Hamilton)
*35. *Crossocheilus latius latius* (Hamilton)
*36. *Garra annandalei* Hora.
37. *Garra gotyla* Gray.
38. *Garra lamta* (Hamilton)
39. *Labeo angra* (Hamilton)
40. *Labeo boga* (Hamilton)
*41. *Labeo bata* (Hamilton)
*42. *Labeo calbasu* (Hamilton)
43. *Labeo dero* (Hamilton)
*44. *Labeo gonius* (Hamilton)
45. *Labeo pangusia* (Hamilton)
*46. *Labeo rohita* (Hamilton)
47. *Labeo sindensis* Day.
*48. *Osteobrama cotio* (Hamilton)
49. *Schizothorax annandalei* Regan.
50. *Schizothorax richardsonii* (Gray)

Family: PSILORHYNCHIDAE

51. *Psilorhynchus pseudecheneis* Menon and Dutta

Family: HOMALOPTERIDAE

52. *Balitora brucei* Gray

Family: COBITIDAE

53. *Botia dayi* Hora.
*54. *Botia histrionica* Blyth.
*55. *Botia lohachata* Chaudhuri.
56. *Lepidocephalichthys annandalei* Chaudhuri
57. *Lepidocephalichthys guntea* (Hamilton)
58. *Noemacheilus botia* (Hamilton)
59. *Noemacheilus rupicola* (McClelland)
60. *Noemacheilus rupicola inglisi* Hora
61. *Noemacheilus savona* (Hamilton)
62. *Noemacheilus scaturigina* (McClelland)
63. *Acanthophthalmus pangia* (Hamilton)

Family: SILURIDAE

64. *Ompok bimaculatus* (Bloch)
65. *Wallago attu* (Schneider)

Family: BAGRIDAE

66. *Mystus aor* (Hamilton)
67. *Mystus bleekeri* (Day)
68. *Mystus seenghala* (Sykes)
69. *Mystus vittatus* (Bloch)
70. *Rita rita* (Hamilton)
71. *Leiocassis rama* (Hamilton)

Family: AMBLYCEPIDAE

72. *Amblyceps mangois* (Hamilton)

Family: SISORIDAE

73. *Bagarius bagarius* (Hamilton)
74. *Gagata cenia* (Hamilton)
75. *Gagata nangra* (Hamilton)
76. *Gagata viridescens* (Hamilton)
77. *Glyptothorax annandalei* Hora
78. *Glyptothorax cavia* (Hamilton)
79. *Glyptothorax horai* Shaw and Shebbeare
80. *Glyptothorax telchitta* (Hamilton)
*81. *Hara jerdoni* Day
82. *Pseudecheneis sulcatus* (McClelland)

Family: SCHILBEIDAE

*83. *Ailia coila* (Hamilton)
84. *Clupisoma garua* (Hamilton)
85. *Clupisoma montana* Hora.
86. *Eutropiichthys vacha* (Hamilton)
*87. *Pseudotropius atherinoides* (Bloch)

Family: HETEROPNEUSTIDAE

*88. *Heteropneustes fossilis* (Bloch)

Family: CLARIIDAE

*89. *Clarias batrachus* (Linnaeus)

Family: BELONIDAE

*90. *Xenentodon cancila* (Hamilton)

Family: CYPRINODONTIDAE

*91. *Aplocheilus panchax* (Hamilton)

Family: MUGILIDAE

*92. *Rhinomugil corsula* (Hamilton)

Family: CHANNIDAE

*93. *Channa marulius* (Hamilton)
94. *Channa orientalis* Schneider
*95. *Channa punctata* (Bloch)
*96. *Channa striatus* (Bloch)

Family: AMPHIPNOIDAE

97. *Amphipnous cuchia* (Hamilton)

Family: AMBASSIDAE

*98. *Ambassis nama* (Hamilton)
*99. *Ambassis ranga* (Hamilton)

Family: NANDIDAE

*100. *Nandus nandus* (Hamilton)

Family: SCIAENIDAE

*101. *Pseudosciaena coitor* (Hamilton)

Family: ANABANTIDAE

*102. *Colisa fasciata* (Schneider)
103. *Colisa lalia* (Hamilton)

Family: GOBIIDAE

*104. *Glossogobius giuris* (Hamilton)

Family: MASTACEMBELIDAE

*105. *Macrognathus aculeatum* (Bloch)
*106. *Mastacembelus armatus* Lacépede
*107. *Mastacembelus pancalus* (Hamilton)

Family: TETRODONTIDAE

*108. *Tetrodon cutcutia* Hamilton.

GENERAL REMARKS

The fishes in the fauna of the Kosi river in the area investigated are widely distributed in India. Menon (1949), while discussing the Zoogeographical significance of the fish fauna of the Kosi system, stated that the occurrence of the most highly evolved torrential fishes like *Balitora brucei, Pseudecheneis sulcatus, Glyptothorax annandalei, G. cavia, G. horai,* several species of *Noemacheilus* and *Lissocheilus hexagonolepis* in the Kosi, showed the close affinity with that of Tista and suggested that some of the earliest tributaries of the Kosi might have drained the region of the Darjeeling Himalayas and are now probably feeder streams of the Tista river. In *dhars* such as Kosi-khanua and Khagna, where the current is not very fast and the river bed is muddy, the fishes like *Gagata, Garra, Noemacheilus* etc. which are hill stream, forms and generally inhabit a rocky substratum, have been collected in good number. This would suggest that these species can infact adapt themselves to the conditions obtained in the rivers of plain. Cultivable species such as *Catla catla, Cirrhinus mrigala, C. reba, Labeo bata, L. rohita, L. calbasu* and *L. gonius* were also collected in abundance from the Kosi-khanua *dhar* where an intensive collection of carp spawn is made every monsoon by commercial parties.

ACKNOWLEDGEMENTS

We are grateful to Dr. V. G. Jhingran, Director, Central Inland Fisheries Research Institute for guidance and Dr. A. V. Natarajan, for critically going through the manuscript and suggesting improvements, to Dr. A. G. K. Menon, Deputy Director, Zoological Survey of India for offering helpful suggestions in the preparation of the manuscript. Thanks are also due to Sri A. G. Prasad, Executive Engineer, Research Division, Kosi Project, Birpur for the help rendered, and to the Director of Fisheries, Govt. of Bihar for extending cooperation in the execution of work.

CENTRAL INLAND FISHERIES
RESEARCH SUB-STATION,
ALLAHABAD, (INDIA),
February 26, 1979.

H. A. KHAN[1]
M. YUSUF KAMAL[2]

[1] Central Inland Fisheries Research Institute, Sahidnagar, Bhubaneshwar-751 007 (Orissa).
[2] Central Inland Fisheries Research Institute, 16, Ashok Nagar, P. O. Argora, Ranchi-834 002 (Bihar).

REFERENCES

CHHIBBER, H. L. (1949): Westward drift of the rivers in North India. *Bull. nat. Geop. Soc. India, 12*: 1-15.

DAVID, A. (1959): Observations on some spawning grounds of the Gangetic major carp with a note on carp seed resources in India. *Indian J. Fish., 6* (2): 327-341.

DEWITT, H. H. (1960): A contribution to the ichthyology of Nepal. *Stanford. Ichth. Bull. 7* (4): 63-88.

MENON, A. G. K. (1949): Notes on fishes in the Indian museum. XLIV. Fishes of the Kosi Himalayas, Nepal. *Rec. Indian Mus., 47*: 231-235.

——————— (1954): Fish geography of the Himalayas. *Proc. nat. Inst. Sci. India, 22*: 467-493.

——————— (1962): A distributional list of fishes of the Himalayas. *J. Zool. Soc. India, 14* (1): 23-32.

——————— (1964): Monograph of the Cyprinid fishes of the genus *Garra* Hamilton. *Mem. Indian Mus., 14* (4): 173-260.

20. SOUTHWARD MIGRATION, OF *EUPLOEA CORE CORE* CR. AT KHANDALA, WESTERN GHATS

During a visit to Khandala, Kolaba District, Maharashtra on 4th October, 1979 we saw several Common Indian Crow butterflies in movement towards the south. They were flying in groups of 8 to 12 butterflies, at about a metre above the ground. However a few were seen at heights of 3 to 4 m, above the ground. The flight was slow. The weather was cloudy with intermittent sunlight, and the wind was blowing from west to east. It was also noted that the butterflies were moving from lower to higher elevations. From 9.10 a.m. to 11.30 a.m. several hundred butterflies crossed the area under observation. Other Danaids like Common Tiger, Blue Tiger and Plain Tigers were also seen in the area.

RESEARCH ASSISTANTS,
BOMBAY NATURAL HISTORY SOCIETY,
BOMBAY 400 023,
October 11, 1979.

NARESH CHATURVEDI
S. M. SATHEESAN

21. ATTRACTION OF BUTTERFLIES TO *CROTALARIA RETUSA* (PAPILIONACEAE) AT KHANDALA, W. GHATS

Butterflies belonging to the Family Danaidae are known to be attracted to plants containing pyrrolizidine alkaloids (for references see Amladi 1975).[1] One such group of plant, is of the genus *Crotalaria*. On 4th October 1979 between 9.05 a.m. to 11.50 a.m., we saw several butterflies sitting on a bush. We collected a branch of this shrub which was later identified as "Shanarghandika" *Crotalaria retusa* (Pailionaceae) also often referred to as Glory of Mahabaleshwar. After alighting on the leaves, the butterflies protruded their proboscis and rubbed it on the surface of the leaf. They were observed on withering leaves

[1] AMLADI, S. R. (1975): Danaid Butterflies attracted to *Heliotropium indicum* (Boraginaceae) an alkaloid containing Plant. *J. Bombay nat. Hist. Soc. 72*: 585-87.

of the plant. When disturbed they returned to the plant after flying around for a short while. On each bush over 60 butterflies were seen. The danaids were, common Indian crow (*Euploea core core*), blue tiger (*Danaus limniace*), common tiger (*D. genutia*), and plain tiger (*D. chrysippus*). What seemed most interesting to us was that four males of the Great Egg Fly (*Hypolimnas bolina*) family Nymphalidae were also seen on the leaves of this plant behaving in a similar fashion.

ACKNOWLEDGEMENT

We are thankful to Prof. P. V. Bole of St. Xavier's College, Bombay for identification of the plant.

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE, OPP. LION GATE,
S. BHAGAT SINGH ROAD,
BOMBAY 400 023,
November 8, 1979.

NARESH CHATURVEDI
S. M. SATHEESAN

22. NEW RECORD OF *MYMAR SCHWANNI* GIRAULT FROM INDIA (HYMENOPTERA: CHALCIDOIDEA, MYMARIDAE)

(*With two text-figures*)

Mymar schwanni Girault

Mymar schwanni Girault, 1912, *Mem. Qd. Mus.* 1: 166-168, ♀; Annecke, 1961, *S. Afr. J. agric. Sci.* 4: 544, 551, ♀, key.

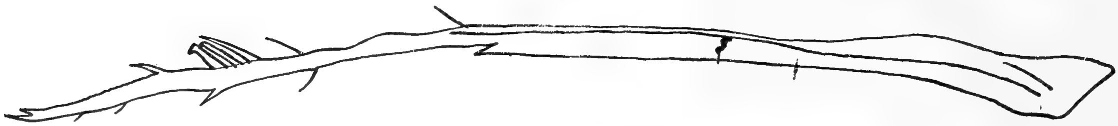
The genus *Mymar* contains five species (Annecke 1961). So far one species, *M. taprobanicum* Ward, is known to occur in India (Hayat 1977). Recently, I collected a single female specimen from Dehra Dun (Uttar Pradesh). The specimen resembles *M. schwanni* Girault according to the key to species given by Annecke (loc. cit.). For confirmation of the identification pencil sketches of the antenna and fore and hind wings were sent to Dr. B. R. Subba Rao, British Museum (NH), who advised that the diagrams are reasonably approximate to those of specimens of *M. schwanni* from Australia present in the British Museum collections. This appears to be the first record of *M. schwanni* from outside Australia.

The species resembles *M. taprobanicum* in several respects including antennal dimensions, but differs in having the hind wings abbreviated beyond the hamuli (figs. 1, 2). It differs from *M. pulchellum* Curtis in greater extension of the infuscation of the fore wings (slightly more than distal half of wing blade infuscated) and greater number of marginal fringe of the fore wings (numbering 41).

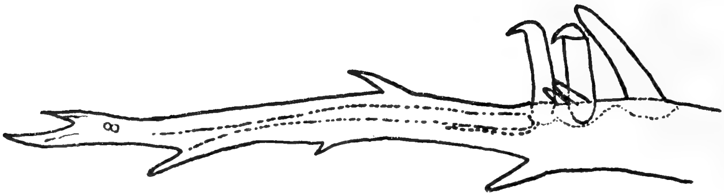
Material examined: INDIA: Uttar Pradesh, Dehra Dun, 1 ♀, 8.iv.1978, collected by sweeping over grass (M. Verma).

ACKNOWLEDGEMENTS

I thank Dr. M. Hayat for valuable suggestions and guidance. Thanks are due to Dr. B. R. Subba Rao, Commonwealth Institute of



1



2

Figs. 1-2. *Mymar schwanni* Girault, ♀: (1) Hind wing, (2) Distal portion of hind wing, enlarged.

Entomology, London, for help in the identification of the specimen. I express my thanks to Prof. S. Mashhood Alam, Head, Department of Zoology, Aligarh Muslim University, Aligarh, for providing the necessary facilities, and to the University Grants Commission, New Delhi, for financial assistance under the Faculty Improvement Programme.

MAHESH VERMA

Department of Zoology,
Aligarh Muslim University,
Aligarh-202 001, U.P.,
September 29, 1978.

References

Annecke, D. P. (1961): The genus *Mymar* Curtis (Hymenoptera, Mymaridae). *S. Afr. J. agric. Sci. 4*: 543-552.

Girault, A. A. (1912): Australian Hymenoptera Chalcidoidea II. *Mem. Qd. Mus. 1*: 117-175.

Hayat, M. (1977): *Mymar taprobanicum* Ward, a new record for Rajasthan, India (Hym.: Chalcidoidea, Mymaridae). *Newsl. zool. Surv. India. 3* (5): p. 283.

23. *NEOXANTHOENCYRTUS* GEN. NOV. FOR INDIAN SPECIES OF *SCELIOENCYRTUS* GIRAULT (HYMENOPTERA: ENCYRTIDAE)

(*With two text-figures*)

Neoxanthoencyrtus gen. nov.

Girault (1915) proposed a new genus *Scelioencyrtus* for the species *S. nigriclavus*, *S. tricolor* and *S. keatsi*. He (1916) synonymized *Scelioencyrtus* with *Xanthoencyrtus* Ashmead. Later, Timberlake (1920), Gahan & Fagan (1923), Mercet (1928), Peck (1963) accepted Girault (1916) in considering *Scelioencyrtus* Girault as synonym of *Xanthoencyrtus* Ashmead. Recently, Compere *et al.* (1960) revalidated the genus *Scelioencyrtus* Girault and described *mymaricoides* under it. However, they said "if no mistake was made by Timberlake in synonymizing *Scelioencyrtus*, it may be de-

sirable to erect a new genus for *mymaricoides*". Shafee *et al.* (1973) tentatively accepted Compere *et al.* (1960) and described *S. indicus* under *Scelioencyrtus*. The characters proposed by Girault (1915) for the type species of the genus *Scelioencyrtus* i.e. "fore wing densely and finely setose, marginal fringe longer than usual, a fifth the greatest wing width" apply well to the genus *Xanthoencyrtus* Ashmead (fig. 1). Therefore, we follow Girault (1916), Timberlake (1920), Gahan & Fagan (1923), Mercet (1928) and Peck (1963) in regarding *Scelioencyrtus* Girault as synonym of *Xanthoencyrtus* Ahmead and a new genus *Neo-*

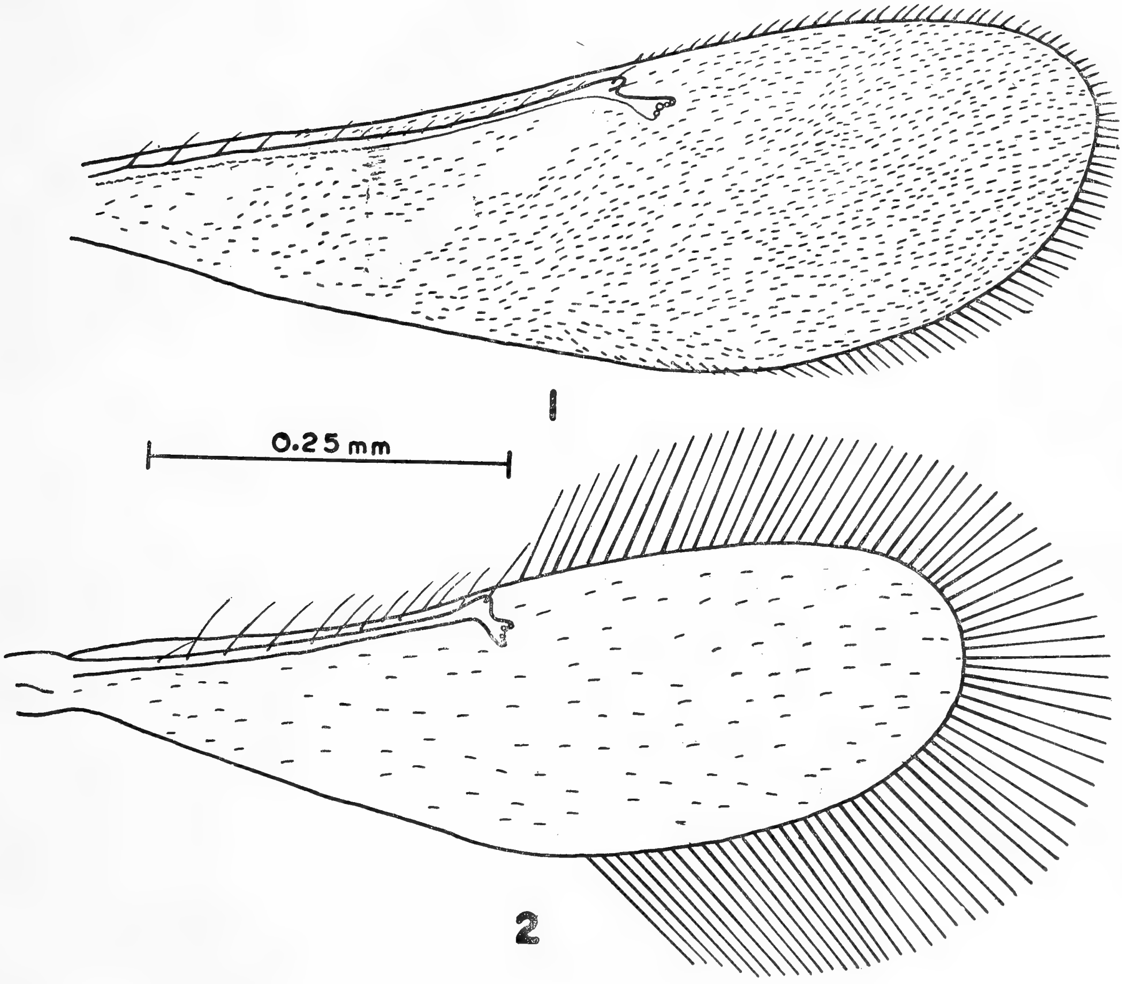


Fig. 1. *Xanthoencyrtus qadrii* Shafee *et al.*, ♀; Fore wing.
Fig. 2. *Neoxanthoencyrtus indicus* (Shafee *et al.*), ♀; Fore wing.

xanthoencyrtus is proposed for *S. mymaricoides* Compere *et al.* and *S. indicus* Shafee *et al.*

Type species: *Scelioencyrtus mymaricoides* Compere *et al.*

Neoxanthoencyrtus gen. nov. differs from *Xanthoencyrtus* Ashmead in the following key characters:

1. Marginal fringe of fore wings short, one-fifth or less the greatest wing width; wings finely setose; marginal vein longer than wide; fore wings with a speculum (fig. 1) .... *Xanthoencyrtus* Ashmead

— Marginal fringe of fore wings long, more than one-half the greatest wing width; wings sparsely and indistinctly setose; marginal vein punctiform; fore wings without speculum (fig. 2; Compere *et al.* 1960, fig. 8) ... *Neoxanthoencyrtus* gen. nov.

Neoxanthoencyrtus mymaricoides (Compere *et al.*) Comb. nov.

Scelioencyrtus mymaricoides Compere *et al.*, 1960, *Proc. natn. Inst. Sci. India,* 26 (B): 46.

Neoxanthoencyrtus indicus (Shafee *et al.*) Comb. nov. (Fig. 2)

Scelioencyrtus indicus Shafee *et al.*, 1973, *Alig. Musl. Univ. Publ.* (*Zool. Ser.*) *Indian Ins. Typ.*, 10: 33.

ACKNOWLEDGEMENT

We are indebted to Prof. S. Mashhood Alam, Head, Department of Zoology, Aligarh Muslim University, Aligarh for providing research facilities.

RAJENDRA KUMAR AVASTHI
SHAIKH ADAM SHAFEE

SECTION OF ENTOMOLOGY,
DEPARTMENT OF ZOOLOGY,
ALIGARH MUSLIM UNIVERSITY,
ALIGARH, INDIA,
August 22, 1978.

REFERENCES

COMPERE, H., SUBBA RAO, B. R. & KAUR, R. B. (1960): Two species of Encyrtidae parasitic in the pink mealy bug of sugar cane in India—(Hymenoptera). *Proc. natn. Inst. Sci. India. 26* (B): 45-50.

GAHAN, A. B. & FAGAN, M. M. (1923): The type species of the genera of Chalcidoidea or Chalcid flies. *Bull. U.S. natn. Mus., 124*: 173 pp.

GIRAULT, A. A. (1915): Australian Hymenoptera Chalcidoidea VII. *Mem. Queensl. Mus., 4*: 1-184.

————— (1916): New Encyrtidae from North America. *Psyche, 23*: 41-50.

MERCET, R. G. (1928): Nota sobre algunos Encyridos americanos (Hym., Chalc.). *Eos., Madrid, 4*: 6-12.

PECK, O. (1963): A catalogue of the Nearctic Chalcidoidea (Insecta: Hymenoptera). *Canad. Ent.* (*suppl.*) *30*: 1092 pp.

SHAFEE, S. A., ALAM, S. M. AND AGARWAL, M. M. (1973): Taxonomic survey of Encyrtid Parasites (Hymenoptera: Encyrtidae) in India. *Alig. Musl. Univ. Publ.* (*Zool. Ser.*) *Indian Ins. Typ., 10*: 1-125.

TIMBERLAKE, P. H. (1920): Description of new genera and species of Hawaiian Encyrtidae (Hym.). *Proc. Hawaii ent. Soc., 4*: 409-437.

24. *SIMPLICIA CAENEUSALIS* WLK. (NOCTUIDAE) AS A PEST OF DRY PALM LEAVES USED IN THATCHED SHEDS IN TAMIL NADU

Recently a peculiar situation of pest incidence was noticed on thatched sheds made of dry coconut and palmyra leaves at Gudiyatham (Tamil Nadu). About 50 huts located in the river bank were severely attacked. The incidence was noticed from November 1976

to January 1977. The pest was identified as *Simplicia caeneusalis* Wlk. (Noct.: Lepidop.). This is the first record of this pest on thatched coconut and palmyra roofs.

Earlier *Simplicia robustalis* Guen. was found to feed on dried *cumbu* stalks, dry fodder of *ragi, cholam* and dry grass in Tamil Nadu and Andhra Pradesh by different workers between the years 1908 and 1941 (Fletcher 1914, Ayyar 1940). Further, this insect has also been noted on the dried groundnut, *Thevitia, Dalbergia* leaves and decaying cotton leaves (Agricultural College & Research Institute, Coimbatore, Insect collection). *Simplicia extinctalis* (Zell.) was observed to feed on sugarcane trash (Carnegie and Dick 1972). There was only one record of *S. robustalis* which was found to feed on thatched shed made up of coconut leaves (Fletcher 1914).

The larvae feed on both dried palmyra and coconut leaves used for thatching the huts. Palmyra leaves are preferred to coconut leaves. In between the layers of thatched leaves various stages of the larvae could be seen feeding from the edges of the dried leaves. They are more active during night time. The dry leaves are completely stripped off into sticks resulting in total destruction. Irregular feeding from the edges except the midrib is also seen. The faecal pellets are seen in large quantities in between the layers of thatchings, and in and around the huts. During day time, the caterpillars fall on the household articles, people and their food materials and cause great annoyance.

The adults are small moths with brown wings and wavy lines on the wings. Which lay eggs on the dry leaflets. The eggs hatch in about 4 days. The caterpillars at early stage are very slender and stick-like. The final instar larvae are dark brownish, soft bodied with transparent skin. Head is brownish with a slight constricted neck. The larval period is about 75 days.

The final stage larvae produce very thin silken strands in the feeding area and transform to reddish brown pupae attached to these strands. The pupal period ranges from 8 to 13 days.

The pupae are parasitised by *Brachymeria* sp. (Chalcidae: Hymenoptera) to an extent of 36.36 per cent.

Thanks are due to the British Museum (Natural History), London for having identified the insect.

M. SWAMIAPPAN
M. BALASUBRAMANIAN

DEPT. OF AGRICULTURAL ENTOMOLOGY,
TAMILNADU AGRICULTURAL UNIVERSITY,
COIMBATORE 641 003,
August 22, 1978.

REFERENCES

AYYAR, T. V. R. (1940): Hand book of Economic Entomology for South India, Govt. Press, p. 375.

CARNEGIE, A. J. M. & DICK, J. (1972): Notes on sugarcane caterpillars (Noctuidae) and effects of Defoliation on the crop. *Proc. South African Sugar Tech. Assn. 46*: 160-67.

FLETCHER, T. B. (1914): Some South Indian Insects. p. 395.

25. MORPHOLOGICAL COLOUR CHANGE IN THE MARINE CRAB, *PORTUNUS PELAGICUS* (RATHBUN)

Colour change may be morphological or physiological. In morphological colour change, the amounts of pigments which are kept constantly dispersed upon a given background increase simultaneously, whereas the amounts of pigments which are kept constantly concentrated on the same background decrease (Keeble & Gamble 1904, Babak 1913, Odiorne 1933).

According to Bowman (1942), in the crayfish, *Cambarus clarkii* after 52 days on a black background the number of white chromatophores decreased as compared to the original number, while red chromatophores increased. On a white background the converse was true. In total darkness a slight increase in chromatophore number was noted over that of normal kept in stock aquaria with brown pebble background. The prawn, *Metapenaeus monoceros* (Madhyastha & Rangnekar, 1971) when subjected to prolonged sojourn on illuminated white and black backgrounds showed a decrease and increase in the number of chromatophores respectively. Under intermittent illumination, the prawns kept on a black background showed a slight increase in the number of chromatophores, while animals on a white background did not show any change. An increase in the chromatophore number was noticed in animals kept in total darkness.

Similar experiments were carried out in the marine crab, *Portunus pelagicus*.

Material and Methods

Animals of both sexes ranging 8-10 cm in carapace width were selected from the stock for study. Chromatophores from the terminal part of the last periopod were counted from an approximate area measuring 1 mm square under a compound microscope (magnification 450 X). These chromatophores were predominently dichromatic, containing black and red, black and yellow or yellow and red pigments with a few monochromatic red, black and yellow ones. Animals were placed under the following five regimens.

A — White background and constant illumination
B — Black background and constant illumination
C — White background and intermittent illumination
D — Black background and intermittent illumination
E — Black background and total darkness

Five animals were kept on each background in sea water which was changed after feeding the animals with crab meat on alternate days. For constant illumination "day light" flourescent tube (20 watts) was used. Animals (group E) maintained in total darkness were kept in a dark room and were exposed to light only during the time necessary for counting their chromatophores. For intermittent illumination the animals were subjected to a day-night cycle. From all the groups, the chromatophores were counted, 7, 14, and 21 days after the commencement of experiment.

Maximal dispersion of the pigments within the chromatophores was found in the animals kept on a black background. In order to facilitate counting of those chromatophores with dispersed pigments, the experimental animals during counting the chromatophores were kept on an illuminated white background for 2

hours only which resulted in a slight concentration in the chromatophores.

Observations

From the Table, it is evident that the number of chromatophores shows a significant increase progressively in all the animals kept on black background under different regimens.

It is also noticed that the difference between the initial reading and the final reading in the animals kept under constant illumination and black background is greater than the difference observed in animals kept under intermittent illumination and black background.

After 21 days, on a black background, the maximum increase in the number of chromatophores was observed in the animals subjected to total darkness and a minimal increase noticed in the animals under intermittent illumination, those subjected to constant illumination on a black background occupying an intermediate position. Under these experimental conditions the animals in the three groups showed progressive increase in the number of chromatophores.

Moreover, after 21 days the chromorhiza of the chromatophores of the animals on a black background subjected to total darkness showed increased arborization and the processes of the adjoining expanded chromatophores intermingled, thereby temporarily losing their identity. This change was less pronounced in animals kept on a black background under intermittent and constant illumination. A progressive decrease in the number of chromatophores was discernible on a white background, both under constant and intermittent illumination. Moreover, taking into consideration the difference in the initial and final readings, the reduction in the chromatophore number on a white background with either

Table

The effects of different regimens of light and backgrounds on the number of chromatophores in the marine crab, *Portunus pelagicus*

Days	Constant illumination		Intermittent illumination		Total darkness
	White background	Black background	White background	Black background	Black background
0	69.6* ± 4.99	52.8 ± 3.91	62.4 ± 3.62	58.4 ± 0.98	56.8 ± 2.04
7	43.6 ± 1.53	64.8 ± 2.33	40.00 ± 2.28	57.2 ± 2.24	77.6 ± 1.60
14	42.4 ± 2.40	69.6 ± 1.86	32.8 ± 2.91	77.6 ± 2.31	84.00 ± 1.94
21	37.6 ± 0.97	80.0 ± 2.19	31.2 ± 0.55	83.2 ± 1.74	90.00 ± 2.16

* Each figure represents the average number of the chromatophores in an area of 1 mm square, of five animals.

constant or intermittent illumination is almost similar.

Discussion

In the crab, *Portunus pelagicus* when kept, on a white background, with either constant or intermittent illumination, the reduction in the chromatophore number is almost similar. The observation that the most striking reduction in the number of chromatophores occurs under constant illumination on a white background (Bowman 1942, Green 1964, Vasantha 1968 and Madhyastha & Rangnekar 1971) is, however, not upheld in the species under investigation. The average number of chromatophores generally increases on a black background. A relatively greater increase was evident under constant illumination than under intermittent illumination. This however, is not in agreement with the findings made on the red chromatophores of the prawn, *Caridina weberii* by Vasantha (1968) and the crayfish, *C. clarkii* by Bowman (1942) and on the black chromatophores of the crab, *Ocypode ceratophthalma* by Green (1964). In the present study, in total darkness and on a black background this increase is greater than under the other two regimens. However, in the prawn *M. monoceros* Madhyastha & Rangnekar (1971) found that, on a black background, the highest and the lowest number of chromatophores were recorded under constant and intermittent illuminations respectively, the number for total darkness occupying an intermediate position. Similar observations were also made on the red chromatophores of *C. weberii* by Vasantha (1968) and *C. clarkii* by Bowman (1942). In *O. ceratophthalma* the finding was entirely at variance as no significant variation occurred despite a treatment of 14 days. The observation that *P. pelagicus* kept under intermittent illumination on a black background has the lowest increase in chromatophore number agrees with finding made in the prawn, *M. monoceros* by Madhyastha & Rangnekar (1971).

Summary

Portunus pelagicus subjected to prolonged sojourn on illuminated white and black backgrounds shows a decrease and increase in the number of chromatophores respectively. A slightly greater increase in the number of chromatophores is observed on a black background under constant illumination than under intermittent illumination. But in total darkness, on a black background the increase in the number of chromatophores is maximum.

D. G. KOLWALKAR
P. V. RANGNEKAR

Department of Zoology,
Institute of Science,
Bombay 400 032,
March 14, 1978.

References

Babak, E. (1913): Relationship of morphological to physiological colour change in vertebrates. *Arch. ges. Physiol. 149*: 462-470.

Bowman, T. E. (1942): Morphological colour change in the crayfish. *Amer. Nat. 76*: 332-336.

Green, J. P. (1964): Morphological colour change in the Hawaiian ghost crab, *Ocypode ceratophthalma. Biol. Bull. Wood's Hole. 126*: 407-413.

Keeble, F. & Gamble, F. W. (1904): The colour physiology of higher Crustacea. II. *Phil. Trans.* B, *196*: 295-388.

Madhyastha, M. N. & Rangnekar, P. V. (1971):

Morphological colour change in the prawn, *Metapenaeus monoceros* (Fabricius). *J. Univ. Bombay Vol. XL.* No. *67*: 54-59.

ODIORNE, J. M. (1933): Morphological colour change, fishes. *Proc. Nat. Acad. Sci. 19*: 329-332.

VASANTHA, N. (1968): Some aspects of endocrinology of the freshwater prawn, *Caridina weberii.* Ph.D. Thesis submitted to the Marathwada University (*unpublished*).

26. EXTENSION OF RANGE OF *TRIOPS CANCRIFORMIS* (BOSC) (BRANCHIOPODA; NOTOSTRACA: APODIDAE) TO POONCH VALLEY (JAMMU & KASHMIR STATE)

The Tadpole shrimp—*Triops cancriformis* (Bosc) is a palaearctic branchiopod, which shows an erratic distribution, being found in several widely-separated localities such as India, England, Lombardy, Munich, Prag, Padua, Breslau, Sweden, and Bingol Dagh (Armenia). In India previous records of *Triops cancriformis* (Bosc) are from Bulandshahar, Nuriwalla, Sargodha District (Punjab), and Kashmir. The present report of *Triops cancriformis* (Bosc) from Poonch Valley (J. & K. State) is, therefore, an extension of range, *Triops* is a fairly serious pest of rice plant feeding actively on young rice plants however it does not do further harm to the plant once (the rice plant is 30 cm high) and is said to be beneficial to the plant, as it works the soil around the roots.

A large number of specimens of *Triops cancriformis* (Bosc) were collected by me from rice-fields in Poonch Valley and compared with specimens obtained from the rice-fields of Sopore and Handwara (Kashmir Valley) as well as from Dal Lake. Detailed examinations of all these specimens have revealed that the Poonch specimens as well as those from Kashmir Valley are conspecific.

As elucidated elsewhere (Tiwari 1972, Nath 1975) the differences between the specimens of *Triops cancriformis* (Bosc) obtained from Kashmir Valley and those from the plains of India are of non-taxonomic value and are probably due to the differences in the biological conditions correlated with high altitude. Therefore, *Apus kashmiriensis* Das and *Triops cancriformis* (Bosc) are considered to be conspecific.

ACKNOWLEDGEMENTS

I am grateful to Dr. G. A. Boxshall of the British Museum of Natural History, London, for confirming the identification of the present collection, as well as to Dr. K. K. Tiwari of the Zoological Survey of India, Calcutta, for his valuable opinion.

SURENDRA NATH

DEPARTMENT OF ZOOLOGY,
ISLAMIA COLLEGE OF SCIENCE & COMMERCE,
SRINAGAR (KASHMIR), INDIA,
November 7, 1979.

REFERENCES

NATH, SURENDRA (1975): Studies on the freshwater Crustacea of Jammu & Kashmir state (India) Part II: On *Triops cancriformis* (Bosc) (Branchiopoda, Notostraca, Apodidae) from Kashmir Valley and adjacent areas, with remarks on the taxonomic status of *Apus Kashmiriensis* Das. *Proc. IIIrd All-India Congress of Zoology.*

TIWARI, K. K. (1972): Taxonomic status of two recently described Branchiopoda from Kashmir, India. *Crustaceana 23* (3): 311-314.

27. OCCURRENCE OF *LIMNOCNIDA INDICA* ANNANDALE MEDUSAE (HYDROZOA: LIMNOCNIDIDAE) FROM FRESH-WATER TANK OF DHORAJI (DIST. RAJKOT, SAURASHTRA)

Freshwater medusae have so far been collected from the valleys of Kistna, Yenna and Koyna rivers (Rao 1932). It has also been recorded from Periyar lake of Kerala (Darling 1935), Krishnarajasagar of Cauvery (Krishnamurthy 1951) and Thunga river of Karnataka (Iyengar & Venkatesh 1955). There is no report of its occurrence in Gujarat State. It is therefore of interest to record the occurrence in rainy season of 1978, of *Limnocnida indica* from stagnant freshwater tank of a mosque near Hazrat Khawaja Mokamuddin Sarani Sahab Dargah and from Naganishah Takiya mosque at Dhoraji (22° 11′ 10″ N, 70° 34′ 30″ S), 135 metres MSL, situated 39 km away from Junagadh.

This tank is an artificial one, square in shape (3 m × 3 m) and its depth is about 1.4 m. The water in the tank is used by the local people. There is no stream flowing into it and water comes from Bhadar Dam (near Jetpur) by pipes.

ACKNOWLEDGEMENT

We are grateful to Dr. T. D. Soota, Superintending Zoologist, Zoological Survey of India, for confirming the identification of the medusae.

BIOLOGY DEPARTMENT,
BAHAUDDIN COLLEGE,
JUNAGADH.

Y. M. DALAL

UNIVERSITY SCHOOL OF SCIENCES,
GUJARAT UNIVERSITY,
AHMEDABAD-380 009,
April 6, 1979.

U. M. RAWAL

REFERENCES

DARLING, P. S. (1935): Occurrence of *Limnocnida* in the Periyar Lake, Travancore. *Nature. 135*: 151.

IYENGAR, H. D. R. AND VENKATESH, K. (1955): Occurrence of the freshwater medusae *Limnocnida indica,* Annandale in Thunga river near Shimoga town. *J. Bombay nat. Hist. Soc. 53*: 151.

KRISHNAMURTHY, D. R. (1951): On the occurrence of the fresh water medusae in the Krishnarajasagar of the Cauvery. ibid. *50*: 955.

RAO, H. S. (1932): Further observation on the freshwater medusa, *Limnocnida indica,* Annandale. ibid. *36*: 210.

28. A SYSTEMATIC ACCOUNT OF CHLOROCOCCALES OF HASSAN DISTRICT, KARNATAKA STATE, INDIA

(*With three plates*)

In an extensive systematic study on the freshwater algae of Karnataka State it was observed that waters of Hassan District supported a large number of Chlorococcales belonging to the families, Hydrodictyaceae, Oocystaceae, Dictyosphaeriaceae, Selenastraceae, Coelastraceae and Scenedesmaceae. All the 32 species are reported for the first time from this area.

Hassan District is situated in the west of Karnataka State lying between 12° 32′-13° 33′ N and 75° 23′—76° 38′ E, with an area of 5855 sq. km. Average rainfall varies from 38 cm to 610 cm and Koalin, Felspar, Quartz, Kanker, and Haemetite are the main soil types. Collections were made from Arsikere, Sakleshpur, Belur, Arkalgood and Hassan proper so as to cover the entire district, during the month of June, 1976.

The length (L), Breadth (B) and the diameter (D) are given in microns (μ). Col. H—1 to 8 refers to the numbers given to the collections made in Hassan District.

Family: HYDRODICTYACEAE

Sub-Family: Hydrodictyoideae

Genus: *Pediastrum* Meyen, 1829, p. 772.

P. angulosum (Ehr.) Menegh. (Pl. I, Fig. 1) Philipose 1967; p. 119, Fig. 39.
Cells 11.0-12.8 μ in D, colony 120-122 μ in D. (col. H-5).

P. duplex Meyen. var. *clathratum* (A. Br.) Lagerh. (Pl. I, Fig. 2) Philipose 1967; p. 122, Fig. 43 e.
Cells 15-16.25 μ in D and Colonies 111.18-114.25 μ in D. (col. H-4).

P. tetras (Ehr.) Ralfs. var. *tetraodon* (Corda) Rabenh. (Pl. I, Fig. 3) Philipose 1967; p. 130, Fig. 45 e.
Cells 13.75-16.25 μ in D. and Colonies 52.0-55.0 μ in D. (col. H-1).

P. tetras (Ehr.) Ralfs. var. *apiculatum* Fritsch. (Pl. I, Fig. 4) Philipose 1967; p. 130, Fig. 45 h.
Cells 7.2-8.75 μ in D. colonies 14.0-16.25 μ in D. (col. H-3).

Genus *Sorastrum* Küetzing, 1845, p. 144.

S. spinulosum Naegeli (Pl. I, Fig. 5) Philipose 1967; p. 133, Fig. 47.
Colony of 8 cells. Cells 6.8-8.0 μ in L, 9.25-10.0 μ in B and spine 3.75 μ in L. (col. H-1).

Sub-Family: Tetraedronoideae

Genus: *Tetraedron* Küetzing, 1845, p. 129.

T. regulare Küetz. (Pl. I, Fig. 6) Philipose 1967; p. 147, Fig. 60 a-d & f.
Cells 24.20-26.25 μ in D. and Spines 5 μ in L. (col. H-1).

Genus *Closteridium* Reinsch 1888, p. 510.

C. siamensis (W. et G. S. West) G. M. Smith (Pl. I, Fig. 7) Philipose 1967; p. 163, Fig. 76.
Cells 6.25-8 μ in B, 15.0-17.0 μ in L and spines 6 μ in L. (col. H-1).
The form is much smaller than the type.

Family OOCYSTACEAE

Sub-Family Oocystoideae

Genus *Gleotaenium* Hansgirg, 1890, p. 10.

G. loitlesbergerianum Hansg. (Pl. I, Fig. 8) Philipose 1967; p. 179, Fig. 88.
Colony 40-41. 25 μ in D, 28.25-29.0 μ in thickness and Cells 11.75-12.5 μ in D. (col. H-3).

Genus *Nephrocytium* Naegeli, 1849, p. 79.

N. obesum W. et. G. S. West. (Pl. II, Fig. 1) Philipose 1967; p. 190, Fig. 106.

Cells 39.2-40.0 μ in L and 20.25-21.56 μ in B. Colony 83.16-84 μ long and 70.84-72.0 μ in B. (col. H-3).

Family DICTYOSPHAERIACEAE

Genus *Dimorphococcus* A. Braun 1855, p. 44.
D. lunatus A. Braun (Pl. II, Fig. 2) Philipose 1967; p. 205, Fig. 115.
Cells 24.64-25.14 μ in L and 8.75-10.25 μ in B. (col. H-1).

Family SELENASTRACEAE

Genus *Ankistrodesmus* Corda, 1838, p. 196.
A. falcatus (Corda) Ralfs; (Pl. II, Fig. 3) Philipose 1967; p. 212, Fig. 121.
Cells 2.00-2.15 μ in B and 45.0-47 μ in L. (col. H-1).
A. convolutus Corda. (Pl. II, Fig. 7) Philipose 1967; p. 212, Fig. 122.
Cells 2.5-3.75 μ in B. and 29.75-31.25 μ in L. (col. H-1).

Genus *Selenastrum* Reinsch, 1867, p. 64.
S. gracile Reinsch (Pl. II, Fig. 4) Philipose 1967; p. 220, Fig. 128.
Cells 3.75-4.75 μ in B. in and 13.0-25.0 μ in L. (col. H-4).

Genus *Kirchneriella* Schmidle, 1893, p. 16 (83)
K. lunaris (Kirchner) Moebius. (Pl. II, Fig. 5). Philipose 1967; p. 223, Fig. 131.
Cells 6.0-8.0 μ in B. and 8.75-12.50 μ L. (col. H-1).

Family COELASTRACEAE

Genus *Coelastrum* Naegeli, 1849, p. 97.
C. cambricum Archer var. *intermedium* (Bohlin) G. S. West (Pl. II, Fig. 8) Philipose 1967; p. 230, Fig. 138 b. Cells 7.5-8.25 μ in D and Colony 32.0-50.0 μ in D. (col. H-3).

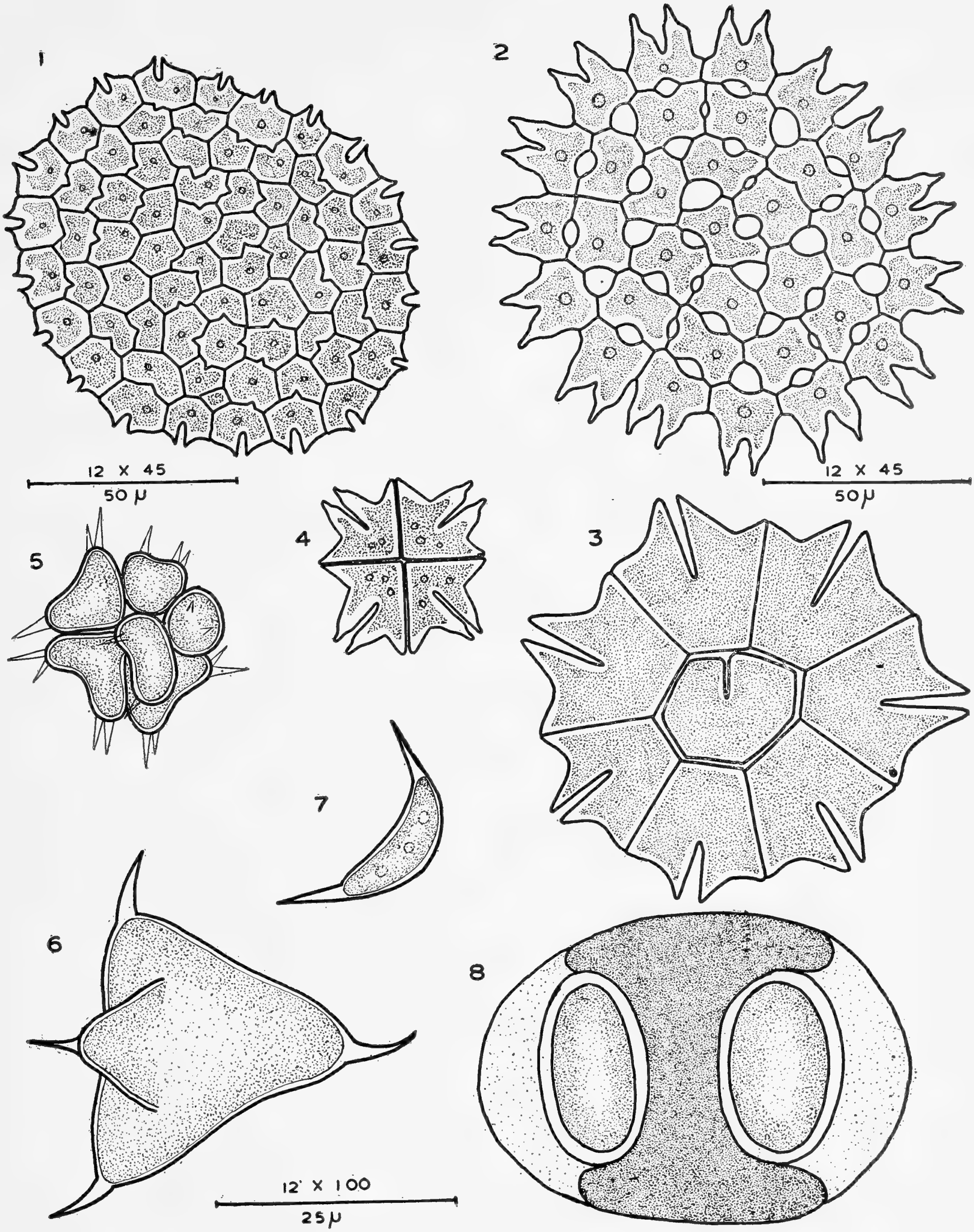
Family SCENEDESMACEAE

Sub-Family Crucigenioideae

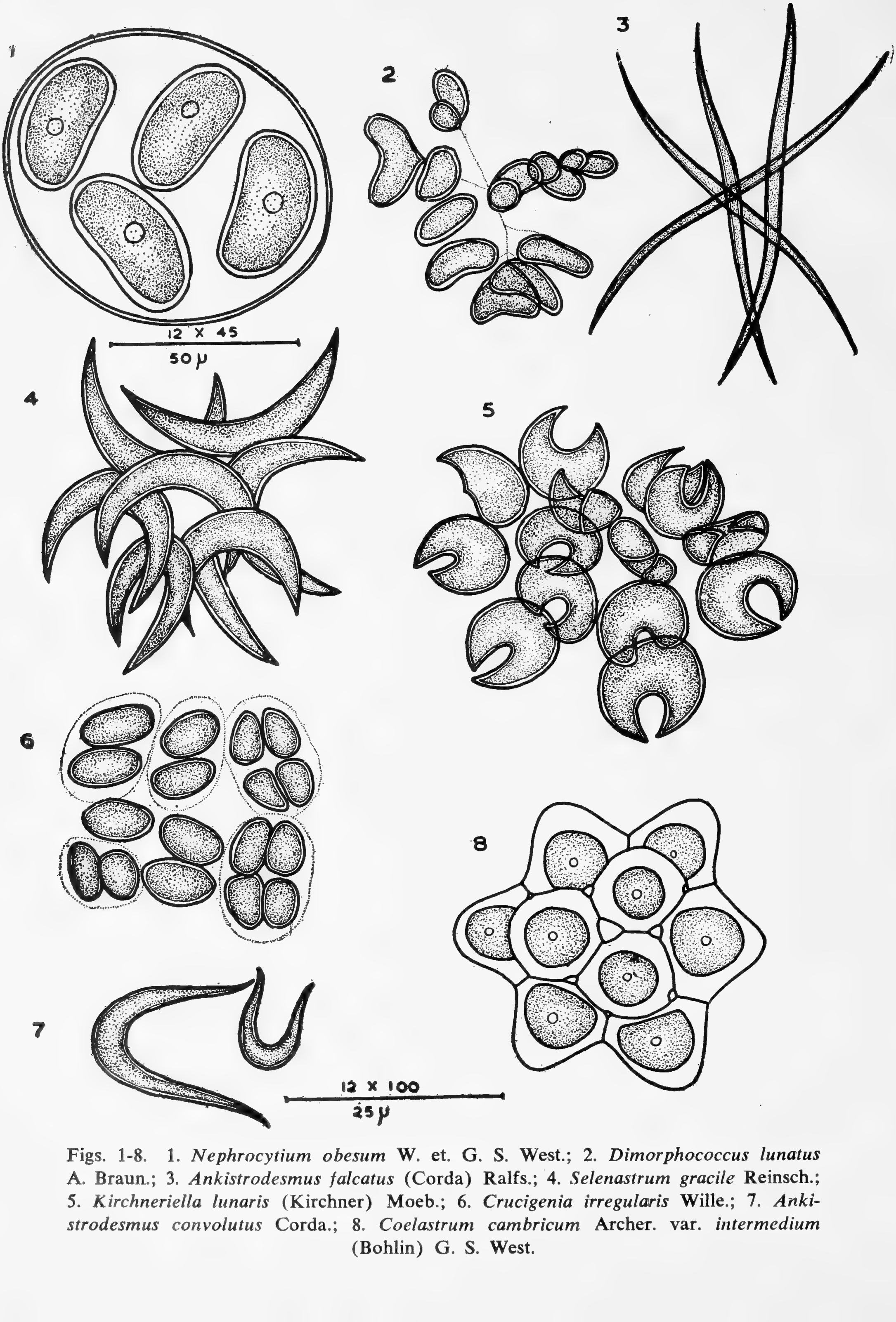
Genus *Crucigenia* Morren 1830, p. 404.
C. irregularis Wille. (Pl. II, Fig. 6) G. W. Prescott 1951; p. 790, Pl. 65, Fig. 6.
Cells 8.75-9 μ in L and 3.75-4.24 μ in B. (col. H-2).

Sub-Family Scenedesmoideae

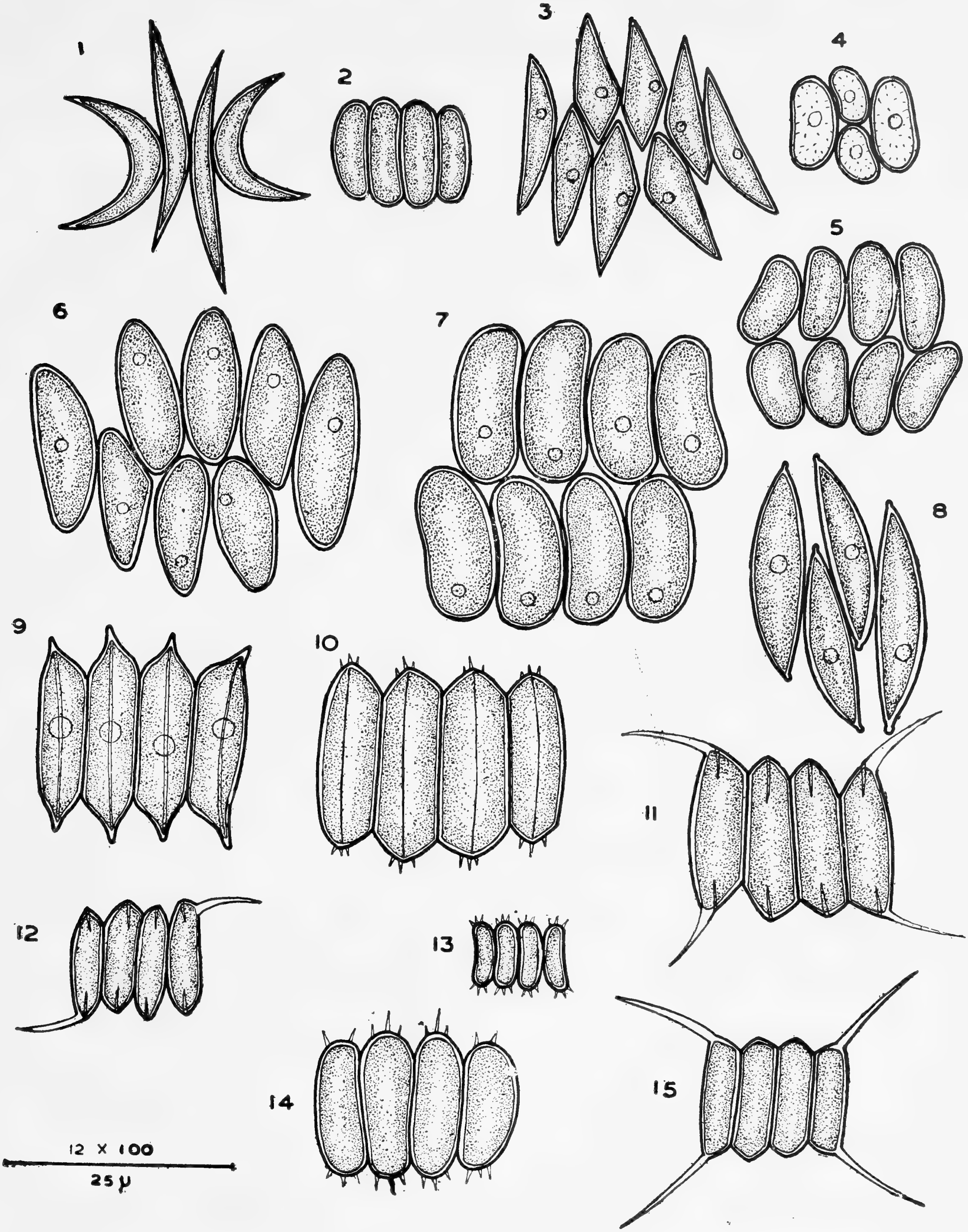
Genus *Scenedesmus* Meyen, 1829, p. 774.
S. dimorphus (Turp.) Küetz; f. *tortus* G. M. Smith, (Pl. III, Fig. 1) Philipose 1967, p. 250, Fig. 160 d.
Cells 2.0-2.30 μ in B. and 16.25-17.50 μ in L. (col. H-7).
S. bijugatus (Turp.) Küetz., (Pl. III, Fig. 2) Philipose 1967; p. 255, Fig. 164 f.
Cells 10-11.75 μ in L and 3.25-3.75 μ in B. (col. H-8).
S. bijugatus (Turp.) Küetz. var. *graevenitzii* (Bernard) Comb. Nov., (Pl. III, Fig. 3) Philipose 1967; p. 255, Fig. 164 a. b.
Cells 3.75-4.7 μ in B and 13.0-13.75 μ in L. (col. H-4).
S. bijugatus (Turp.) Küetz. f. *irregularis* Wille (Pl. III, Fig. 6) Philipose 1967; p. 255, Fig. 164 i, m.
Cells 6.25-7.50 μ in B. and 15.0-15.75 μ in L. (col. H-3).
S. bijugatus (Turp.) Küetz. var. *flexuosus* Lemm. (Pl. III, Fig. 4) Philipose 1967; p. 255, Fig. 164 1.
Cells 4-4.75 μ in B and 7.75-8.25 μ in L. (col. H-3).
S. arcuatus (Lemm) Lemm. (Pl. III, Fig. 7) Philipose 1967; p. 258, Fig. 166 a-c.
Cells 6.0-6.25 μ in B and 14.25-15 μ in L. (col. H-1).
S. arcuatus (Lemm) Lemm. var. *platydisca* (Pl. III, Fig. 5) G. W. Prescott 1951; p. 275, pl. 62. Figs. 10-12.



Figs. 1-8. 1. *Pediastrum angulosum* (Ehr.) Menegh.; 2. *P. duplex* Meyn. Var. *clathratum* (A. Br.) Lagerh.; 3. *P. tetras* (Ehr.) Ralfs. var. *tetraodon* (Corda) Rabenh.; 4. *P. tetras* (Ehr.) Ralfs. var. *apiculatum* Fritsch.; 5. *Sorastrum spinulosum* Naegeli.; 6. *Tetraedron regulare* Küetz.; 7. *Closteridium siamensis* (W. et G. S. West); 8. *Gloeotaenium loitlesbergerianum* Hansg.



Figs. 1-8. 1. *Nephrocytium obesum* W. et. G. S. West.; 2. *Dimorphococcus lunatus* A. Braun.; 3. *Ankistrodesmus falcatus* (Corda) Ralfs.; 4. *Selenastrum gracile* Reinsch.; 5. *Kirchneriella lunaris* (Kirchner) Moeb.; 6. *Crucigenia irregularis* Wille.; 7. *Ankistrodesmus convolutus* Corda.; 8. *Coelastrum cambricum* Archer. var. *intermedium* (Bohlin) G. S. West.



Figs. 1-15. 1. *Scenedesmus dimorphus* (Turp.) Küetz f. *totus* G. W. Smith.; 2. *S. bijugatus* (Turp.) Küetz.; 3. *S. bijugatus* (Turp.) Küetz. var. *graevenitzii* (Bernad) Comb. Nov.; 4. *S. bijugatus* (Turp.) Küetz. var. *flexuosus*. Lemm.; 5. *S. arcuatus* (Lemm.) Lemm. var. *platydisca*.; 6. *S. bijugatus* (Turp.) Küetz. var. *irregularis* Wille.; 7. *S. arcuatus* (Lemm.) Lemm.; 8. *S. arcuatus* (Lemm.) Lemm. var. *capitatus* G. M. Smith.; 9. *S. acutiformis* Schroeder.; 10. *S. brasiliensis* Bohlin.; 11. *S. armatus* (Chodat) G. M. Smith.; 12. *S. armatus* (Chodat) G. M. Smith var. *bicaudatus* (Guglieminetti) Chodat.; 13. *S. denticulatus* (Lagerh) var. *lunatus* W. et G. S. West.; 14. *S. denticulatus* (Lagerh); 15. *S. quadricauda* (Turp.) Breb.

Cells 4.0-4.5 μ in B and 14.25-15 μ in L. (col. H-6).

S. arcuatus (Lemm) Lemm. var. *capitatus* G. M. Smith (Pl. III, Fig. 8) Philipose 1967; p. 258, Fig. 166 1.

Cells 4.25-5 μ in B and 13.00-13.75 μ in L. (col. H-1).

S. acutiformis Schroeder (Pl. III, Fig. 9) Philipose 1967; p. 240, Fig. 169 a.

Cells 5.25-6 μ in B and 21.25-22.5 μ in L. (col. H-1).

S. brasiliensis Bohlin. (Pl. III, Fig. 10) Philipose 1967; p. 260, Fig. 170 a.

Cells 5.25-6.25 μ in B and 22.25-22.75 μ in L. (col. H-1).

S. armatus (Chodat) G. M. Smith, (Pl. III, Fig. 11) Philipose 1967; p. 260, Fig. 17 a.

Cells 5.25-6.25 μ in B and 21.75-22.5 μ in L. (col. H-1).

S. armatus (Chodat) G. M. Smith, (Pl. III, Fig. 11).

Philipose 1967; p. 263, Fig. 171 a.

Cells 5.75-6.25 μ B and 15.0-15.75 μ in L. (col. H-1).

S. armatus (Chodat) G. M. Smith var. *bicaudatus* (Guglielmetti) Chodat, (Pl. III, Fig. 12) Philipose 1967; p. 163, Fig. 171 d. Cells 2.5 μ in B. and 10.0-11.25 μ in L, spines 5-6 μ in L. (col. H-1).

S. denticulatus Lagerh. var. *linearis* Hansgirg., (Pl. III Fig. 13) Philipose 1967; p. 269, Fig. 176 e.

Cells 2.5 μ —3.0 ü in B and 8.75-9.0 μ in L. (col. H-1).

S. denticulatus Legern. (Pl. III, Fig. 14) G. W. Prescott 1951; p. 276, Pl. 61, Fig. 10, 11. Cells 4.25-5.0 μ in B. and 13.75-14.25 μ in L. (col. H-5).

S. quadricauda (Turp) Breb. (Pl. III, Fig. 15) Philipose 1967; p. 283, Fig. 187 a.

Cells 3.75-4.0 μ in B and 12.5-13.25 μ long. Spines 9.0-9.5 μ in L. (col. H-5).

ACKNOWLEDGEMENTS

Our sincere thanks are due to the C.S.I.R. for the financial assistance to one of us (G. R. Hegde). Thanks are also due to Prof. M. S. Channaveeraiah, Head of the Department of Botany, Karnatak University, for the facilities afforded.

S. G. BHARATI
G. R. HEGDE[1]

DEPT. OF BOTANY,
KARNATAK UNIVERSITY,
DHARWAR 580 003,
November 8, 1977.

REFERENCES

PHILIPOSE, M. T. (1967): Chlorococcales. ICAR. New Delhi, Publication.

PRESCOTT, G. W. (1951): Algae of the Western Great Lakes Area Exclusive of Desmids and Diatoms.

[1] C. S. I. R. Research Scholar.

29. RECORD OF *ERIA BRACTESCENS* LINDL. FROM NAGALAND

(*With a text-figure*)

During a botanical exploration trip to the state of Nagaland in 1973, an interesting species of *Eria* Lindl. (Orchidaceae) was collected, which is identified as *Eria bractescens* Lindl., a species hitherto reported from Sikkim (Hooker 1890, King & Pantling 1898, Mitra 1958) and Andaman islands (Seidn. & Smitnd. 1960). This note reports the occurrence of this taxon in Nagaland. Since the characters of the plant are represented by illustrations (Fig. 1, A-G), a brief description only is given here.

Epiphytic on *Quercus* sp., pseudobulbs yellowish brown, wrinkled, base with purplish sheaths; leaves pale green, subcoriaceous; peduncle pale yellow, suberect; raceme lax, slender; flowers pale pinkish yellow; floral bract pale yellow, reflexed; dorsal sepal narrowly elliptic, apex curved backwards; lateral sepals ovate, falcate with yellowish, conical mentum; petals linear oblong, apex revolute; labellum ovate, 3-lobed; side lobes deep pink, round, erect; mid lobe creamy, quadrate with 3 red lamellae; column pinkish yellow; anther 2-celled; pollinia 8, in fours, pale yellow.

Specimens examined: Pulebadze, *c*. 2375 m. *Hynniewta* 56298.

Flowering: April.

Distribution: Sikkim & Andaman islands (India), Bangladesh, Burma, Sumatra and Malaya to the Philippines, Laos, Cambodia, Thailand, Java.

But for its inflorescence, the plant resembles the glabrous herb *Eria confusa* Hook. f., but the differently coloured smaller flowers, reflexed floral bract and erect side lobes of labellum separate it from the later.

T. M. HYNNIEWTA

BOTANICAL SURVAY OF INDIA,
EASTERN CIRCLE,
SHILLONG-793 003,
May 20, 1978.

REFERENCES

HOOKER, J. D. (1890): Fl. Brit. India *5*: 796.

KING, G. & PANTLING, R. (1898): *Ann. Roy. Bot. Gard. Calcutta 8* (1): 120, t. 166.

MITRA, J. N. (1958): *Fl. Pl. East. India 1*: 320.

SEIDENFADEN, G. & SMITINAND, T. (1960): *Orch. Thailand 2* (2): 305.

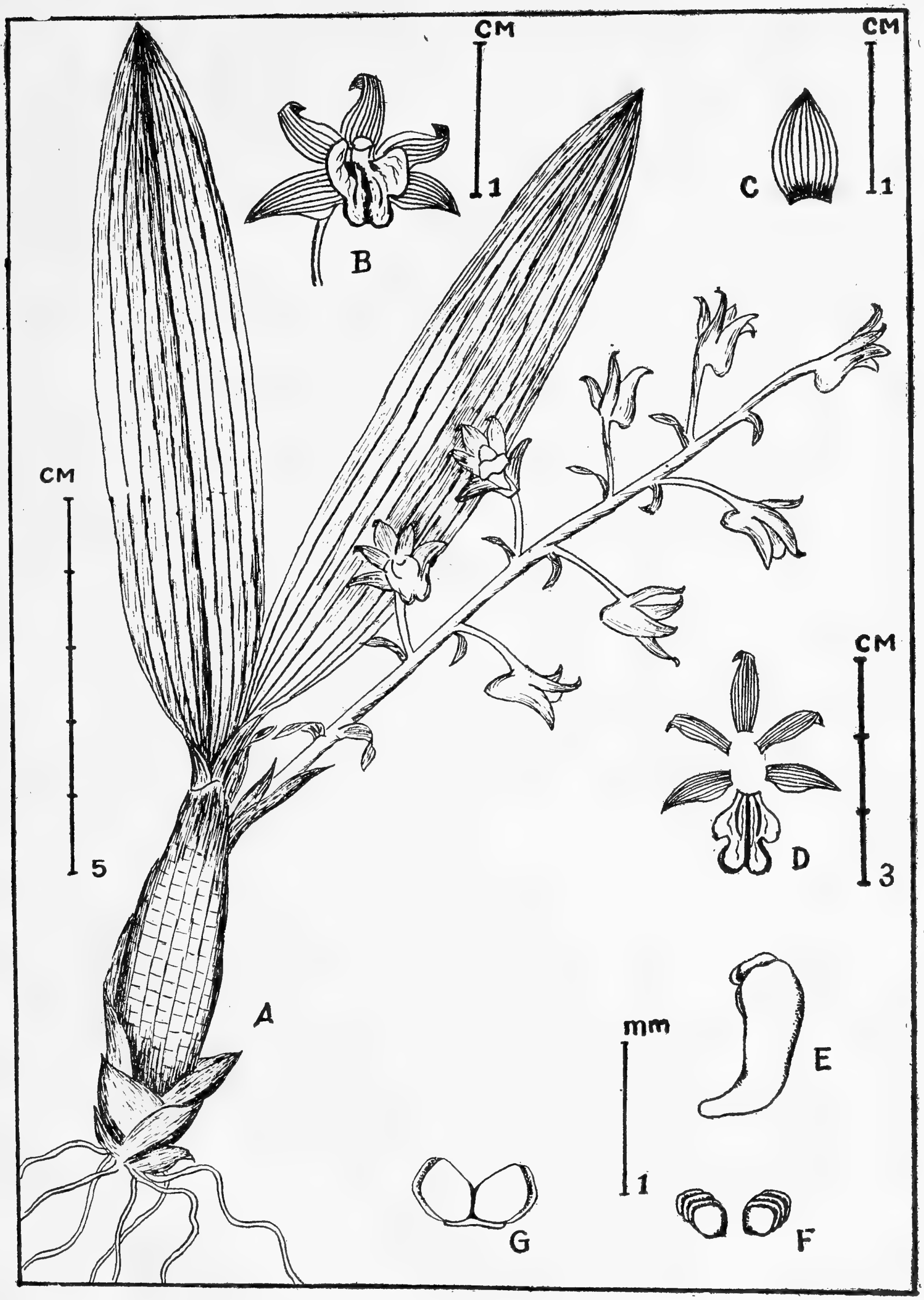


Fig. 1. *Eria bractescens* Lindl.: A-habit. B-flower. C-floral bract. D-perianths with labellum spread out. E-column. F-pollinia, G-anther.

30. *DATURA FEROX* LINN., A NEW RECORD FOR INDIA

(*With five text-figures*)

The genus *Datura* Linn. (Solanaceae) with nearly 10 annual species is represented in India by only 3 species. Recently a species of *Datura* was collected which could neither be matched with any known species in India and nor could it be matched with any of the collections found in Indian Herbaria. It has, however, been identified to be *Datura ferox* Linn,, which is a native of the warmer regions of China, but is believed to have been introduced at an early date in Spain and Sicily (Safford 1921). Very recently, however, it is reported to have spread widely throughout the warm regions of the world. It is now being recorded for the first time from India where it seems to be a recent migrant.

To facilitate the identification and study of the plant, a detailed description with drawings, is provided.

Datura ferox Linn. Amoen. Acad. 3: 403. 1756; Haegi, Aust. J. Bot. *24*: 415-35. 1976. (Figs. 1-5).

A 0.5—1 m tall, annual herb; branches stout, hairy, green or purplish towards the base. Leaves 10-15 × 7—12 cm, broadly ovate to rounded—triangular, margins coarsely double lobed, irregular; base oblique, often shortly decurrent on the petiole, obtuse to truncate, apex acute or acuminate; petiole 2.5—8 cm long, sparsely hairy. Flowers white, solitary; peduncle 0.5—1.5 cm long. Calyx 2.5—3 cm long, angular, narrowed towards the summit with 5 prominent longitudinal ribs; lobes 5, 4-7 mm long, tomentose inside. Corolla 4.5—6 cm long, white, throat and limb often slightly plicate; lobes 5, very short, broadly triangular; acumens 0.1—0.2 cm long. Stamens 5, adnate to the corolla, 1.5 cm from the base; anthers 3-4 mm long, white. Style 3 cm long; stigma 1-2 mm across. Capsule erect, ellipsoid to broadly ellipsoid, rarely subglobose, 2-4 cm long, 2-3 cm broad, beset with 40-60 stout, sharp, conical spines; spines longer near the capsule summit, 15-25 mm long, minutely tomentose; dehiscence through 4 entire valves when ripe; peduncle stout. Persistent calyx base 0.4-0.8 cm long, more or less cylindrical, margin crenate to dentate. Seeds D-shaped, 0.4-0.5 cm long, thickened and rounded towards the upper outer margin, black, finely reticulate—foveate; hilum triangular.

A weed of cultivation or waste places along roads.

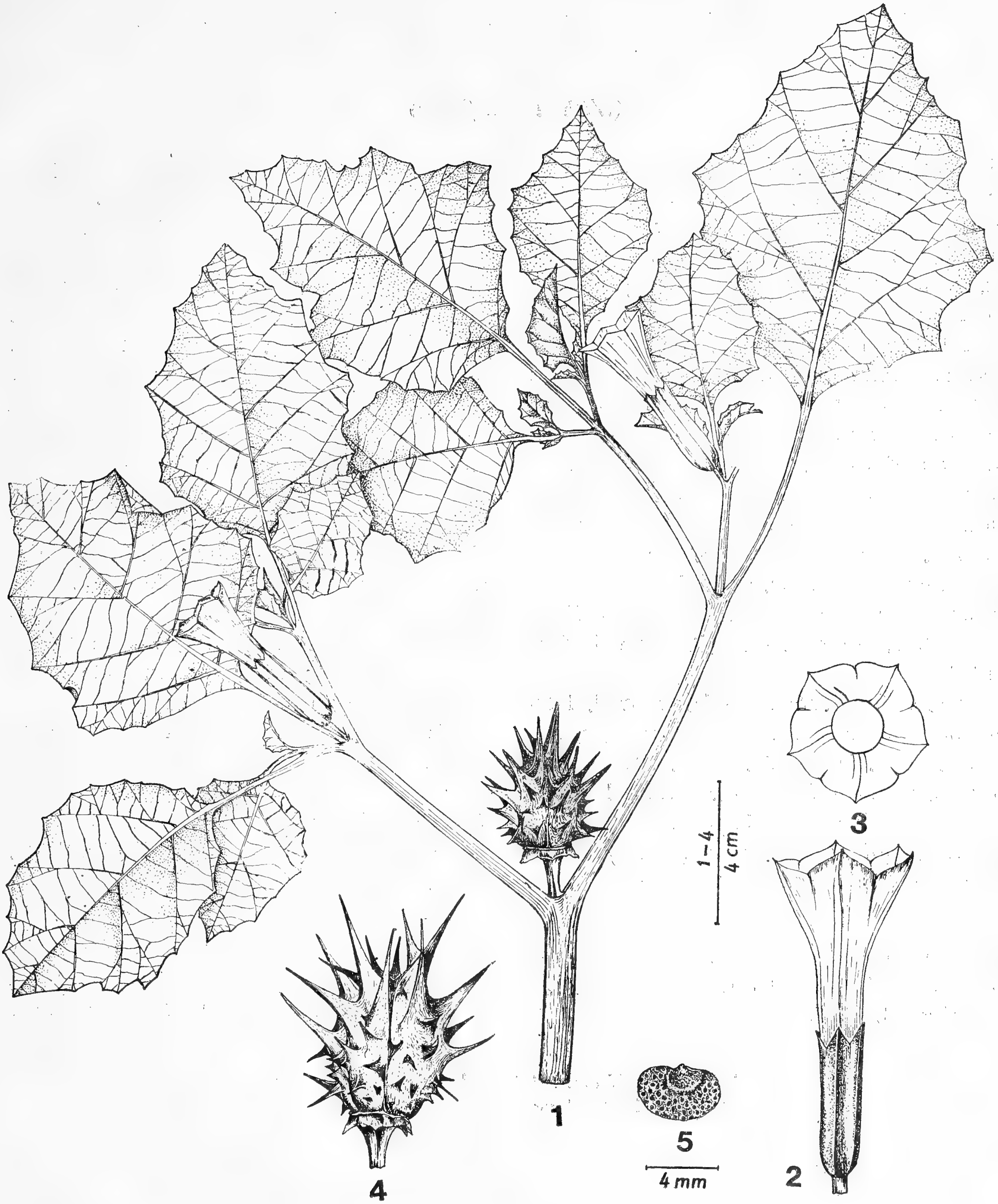
Fls. & Frs.: September-December.

Herbarium specimens: *Bhandari* 2219; Jodhpur, on way to Sardarsamand, October 1976.

Distribution: A native of the warmer regions of China, now distributed widely throughout the warm regions of the world.

M. M. BHANDARI
M. R. MEHTA

BOTANY DEPARTMENT,
JODHPUR UNIVERSITY, JODHPUR,
RAJASTHAN,
November 8, 1977.



Figs. 1-5. *Datura ferox* Linn. 1. Branch with flowers and fruit; 2. Flower; 3. Corolla from above; 4. Fruit; 5. Seed.

31. *BURMANNIA CHAMPIONII* THW.—AN ADDITION TO THE FLORA OF SOUTH INDIA

(*With a text-figure*)

During a recent plant exploration visit to the forests of Silent Valley, Palghat Dist., Kerala, marked for clearance for dam construction, a small, slender, more or less flexuous, unbranched, white, saprophytic plant was found growing in the decaying leafmould of the forest floor. On critical study, it has been identified as *Burmannia championii* Thw. This is the first report of its occurrence in India; the previous reports being from Sri Lanka, southern parts of China, Japan and Malaysia. A detailed description and illustration is furnished below incorporating the intraspecific variations observed, to facilitate locating this rare plant from other forest areas, as well.

Burmannia championii Thw. Enum. Pl. Zeyl. 325. 1864; Hook. f. Fl. Brit. India 5: 666. 1888.

Herbs, 4-13 cm, *stem* simple, grooved, 1-1.5 mm diam. *Scales* 4-15, spirally arranged, appressed, erect, lanceolate, acute, 5×2.5 mm, glabrous, 1-nerved. *Inflorescence* a bifid cincinnus cyme. *Flowers* 2-7, trimerous, white, erect, subsessile, with 3 prominent primary ridges alternating with secondary ones. *Bracts* triangular—lanceolate, acute, 4×2 mm, (apical ones shorter and narrower) glabrous, 1-nerved. *Perianth tube* trigonous, 6×1 mm, glabrous; *outer perianth lobes* lanceolate, acuminate, 2.5×1.5 mm, thick, with involute papillose flap at the margin; *inner lobes* ligulate, acute, 1.5×0.25 mm, reflexed at margins, papillose. *Stamens* 3, opposite to the inner perianth lobes, attached a little below the lobes, with very short filament; *anther* dumbbell shaped; *connective* broad with a median inflexed mucro and two lateral teeth. *Ovary* inferior, trigonous, ellipsoid—obovoid, 4.5×1.5 mm, glabrous, unilocular with three parietal placentae; *ovules* many. Style with stigma 6 mm long; *style* filiform, 3-branched at the tip bearing terminal stigmas; *stigma* funnel shaped, with a broad rotund undulate membraneous appendage.

It is interesting to note that the perianth persists and shows slight elongation after anthesis.

Flowering: September-October.

Specimens examined: Kerala, Panthanthode, 900 m, 21-9-1977, *J. Joseph* 51427 (MH).

BOTANICAL SURVEY OF INDIA,
COIMBATORE, TAMIL NADU,
December 28, 1977.

J. JOSEPH[1]
R. ANSARI
C. N. MOHANAN

[1] *Present address*: Botanical Survey of India, Eastern Circle, Shillong.

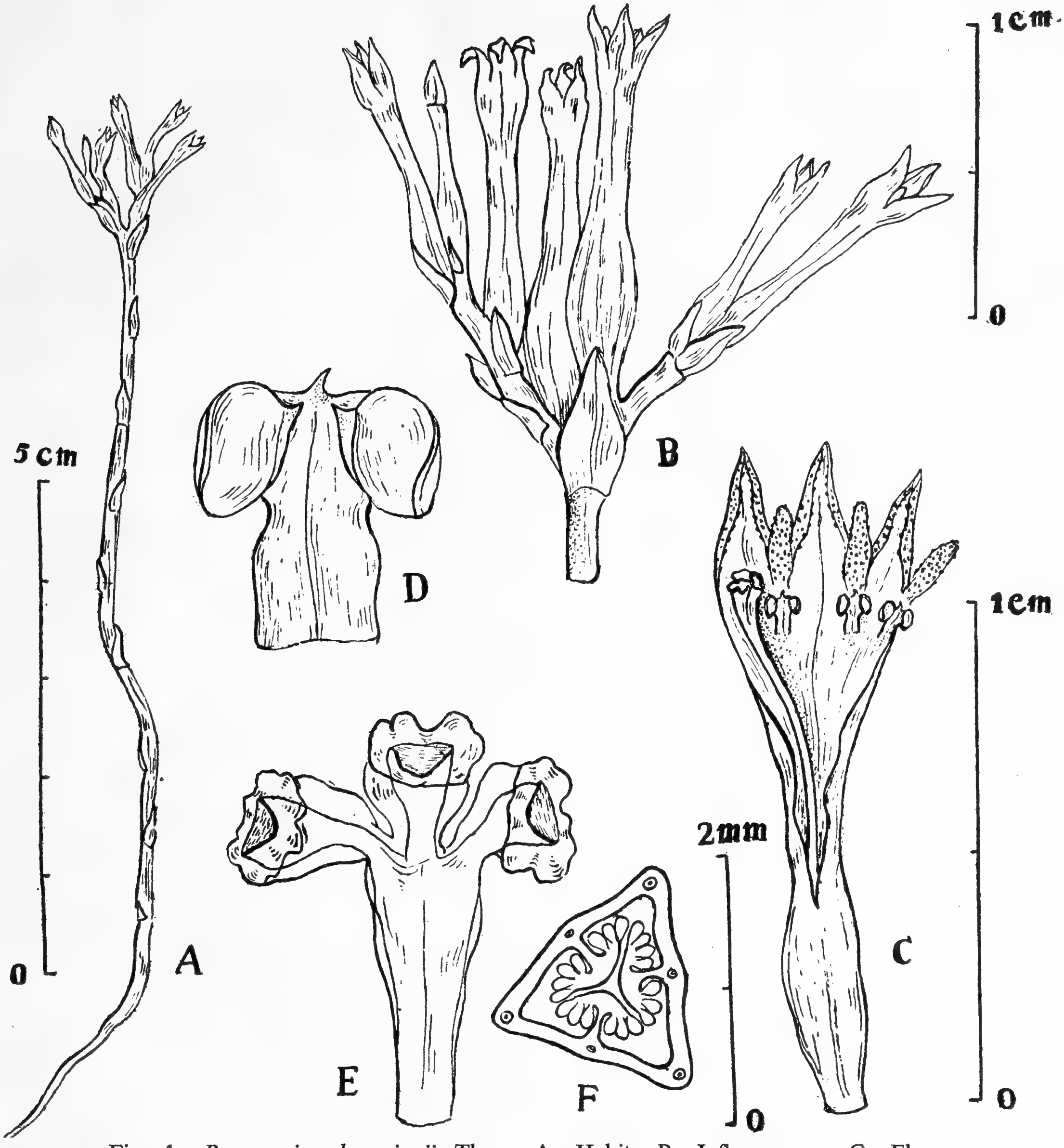


Fig. 1. *Burmannia championii* Thw.: A. Habit; B. Inflorescence; C. Flower—Perianth tube split open; D. Stamen; E. Stigma; (D and E, not to scale) F. Cross section of ovary.

32. A CRITICAL NOTE ON *RHUS JAVANICA* L. (ANACARDIACEAE)

The taxon under reference was erected by Linnaeus in his Sp. Pl. 1: 265. 1753, based on Osbeck's collection from Java. But its locality was further rectified as China in his Sp. Pl. 1: 380. 1762 (ed. 2). The recent flora of Java (Backer and Bakhuizen 1965) does not include the taxon from Java as was previously stated by Linnaeus. Decandolle (1825) recognised two varieties under *R. semialata* Murr. (1) var. *osbeckii* DC. (with broadly winged petiole) based on Osbeck's specimen from China and Thunberg's specimens from Japan and (2) var. *roxburghii* DC. (with narrowly winged or wingless petiole) based on Roxburgh's specimen from N. E. Himalaya. Engler (1883) also supported the view expressed by De Candolle in regard to the two varietal taxa under *R. semialata* Murr. Engler further stressed on the extensive distribution of *R. semialata* Murr. var. *roxburghii* DC. from N. W. Himalaya to N. E. Himalaya and upto China and consequently reduced another species *R. chinensis* Miller as one of its synonyms. Hooker (1876) did not recognise any variety under *R. semialata* Murr. Rehder (1940) and Kitamura (1953) have established *R. chinensis* Miller as a separate species. Recently Hara (1954) has reduced *R. chinensis* Miller as a synonym of *R. javanica* L. which is the legitimate name of the plant having broadly winged petiole.

The nomenclature, synonymy and distribution of the two taxa-(1) with broadly winged petiole and (2) with narrowly winged or wingless petiole are given below:

(1) **Rhus javanica** L., Sp. Pl. 1: 380. 1762 (ed. 2); Hara Enum. Sperm. Jap. 3: 65. 1954; Hiroo Kanai in Hara's Fl. East. Himal.: 186. 1866 & 76. 1975. *R. chinensis* Miller, Gard. Dict. no. 7. 1768 (ed. 8); Rehder Man. Cult. Trees & Shrub: 543. 1940; Kitamura in Kihara's Fauna and flora Nep. Himal.: 173. 1953. *R. semialata* Murr., in Comm. Soc. Sci. Goett. 6: 27. t, 3. 1784. *R. semialata* Murr. var. *osbeckii* DC., Prodr. 2: 68. 1825; Engl. in DC. Mon. Plan. 4: 378. 1883.

Distribution: China, Japan.

(2) **R. javanica** L. var. **roxburghii** (DC.) D. Chandra, comb. nov. *R. semialata* Murr. var. *roxburghii* DC., Prodr. 2: 68. 1825. pp.; Engl. in DC. Mon. Phan. 4: 378. 1883. pp. *R. buckiamela* Roxb. (Hort. Beng.: 22. 1814 & Icon. n. 1228, nom. nud.), Fl. Ind. 2: 99. 1832. pp. *R. amela* D. Don, Prodr. Fl. Nep. 2: 248. 1825. pp. *R. chinensis* Miller, Engl. in DC. Mon. Phan. 4: 378. 1883 (as syn.) pp. *R. chinensis* Miller var. *roxburghii* (DC.) Rehder, Man. Cult. Trees & Shrub: 543. 1940.

Distribution: India and China.

ACKNOWLEDGEMENTS

I am grateful to the Director, Botanical Survey of India, Deputy Director, Central National Herbarium, Botanical Survey of India, for facilities and also thankful to Dr. R. B. Ghosh, Systematic Botanist, Central National Herbarium, for valuable instructions and encouragement.

DALI CHANDRA

CENTRAL NATIONAL HERBARIUM,
BOTANICAL SURVEY OF INDIA,
INDIAN BOTANIC GARDEN,
HOWRAH-711 103,
May 16, 1978.

33. NOTES ON *CLEOME RUTIDOSPERMA* DC. IN INDIA

This paper reports the occurrence of *Cleome rutidosperma* DC. (Capparaceae) an African weed, in Assam and West Bengal, with additional notes on taxonomic characters and possible modes of distribution.

The species now grows wild in different parts of Lower Gangetic Plains and Brahmaputra valley. It is a decumbent diffuse annual having trifoliate leaves and pink flowers with bluish anthers, flowering at the beginning of the monsoon. The taxon has been identified as *Cleome rutidosperma* DC. (Capparidaceae). It has been described and illustrated by M. Jacobs in FLORA MALESIANA Ser. 1, 6(1): 104-105, Dec. 1960 and P. K. Mukherjee in Ind. For. 95(4): 237, 1969. Some characters of taxonomic importance which have not been included in these descriptions are noted here to facilitate the identification of the plant in the field.

The taxon has been reported already by Mukherjee (1969) from the Lady Brabourne College Compound, Calcutta and on Wastelands, Calcutta University Campus, Ballygunge Circular Road, Calcutta, apparently as an escape from cultivation. The exsiccatae at CAL herbarium and also fresh collection from the vicinity of Calcutta, however, leaves no doubt that it is now naturalized in eastern India. The paucity of report of its occurrence may be due to difficulty in identification. Its report from Burma and Malaya possibly suggests its introduction there by human agency at an earlier date and subsequent migration through Assam into eastern India. It may also be looked for in Tamil Nadu area which is on the trade route from Africa to Malaysia.

Cleome rutidosperma DC. Prodr. 1: 241, 1824; Jacobs in Fl. Males. Ser. 1, 6(1): 104-105, figs. 30 et 33, Dec. 1960; Iltis in Brittonia 12: 290-294, 1960.

Annual diffuse herb pinkish on young nodes. Petioles up to 5 cm. long, grooved adaxially. Flowers in the axils of leaves of three leaflets (not in the axils of reduced leaves as reported in Malaysian and American plants). Sepals awl-shaped, fleshy (when fresh), green pinkish at tips. Petals pinkish (no yellow transverse band, in fresh specimens as recorded in American plants). Anthers bluish, filaments faint blue. Fruits slightly flat, bilaterally ribbed, straight, long-beaked. Seeds many, arranged in 4-rows on 1-2 mm. green (fresh) placentae.

Specimens examined:
INDIA: *West Bengal*: flowering and fruiting 10-7-75 on open amphibic waste lands of the district of 24-Parganas (South Barasat, Sonarpur) and Kasba, at the outskirts of Calcutta, *R. B. Majumdar* 7502 (CAL); 24-Parganas, Bansdroni, near Tallygunge. 31-5-1965 rare in Waste places, flowers pinkish white *R. L. Mitra* 147 (CAL), Dakshmin Barasat, 10-7-1975, common in open waste land, flowers pinkish filaments faint blue. *R. N. Banerjee & Barin Ghosh* s.n. (CAL); Indian Botanic Gardens, 18th Aug. 1975, Procumbent annual herbs, flowers pinkish, not common, *O. P. Misra* s.n. (CAL); *Assam*: Gauhati, a flowering and fruiting specimen, 1969, *A. C. Datta* 85 (CAL).

Distribution: Trop. Africa, United States and S. America, Malaysia, Singapore and Burma, Eastern India—Bengal and Assam.

BOTANICAL SURVEY OF INDIA,
HOWRAH-711 103,
February 28, 1978.

BARIN GHOSH
R. N. BANERJEE

34. CORRECTIONS AND ADDITIONS TO THE PTERIDOPHYTIC FLORA OF KODAIKANAL (SOUTH INDIA)

Some years ago we (Bir & Vasudeva 1971) published a taxonomic account of ferns and fern-allies of Kodaikanal situated on the Palni Hills in Madurai district of the state of Tamil Nadu, South India. Further collections made in 1975 and re-examination of the material earlier collected, have revealed several new points about the specific determinations. Also information is given about the latest valid name or about the original publication of the specific names which were earlier given either incompletely or wrongly. The chief points as brought out in the the present studies are as follows:

1. *Botrychium lanuginosum* Wall. ex Hook. & Grev., Ic. Fil. 1. t 79.1831.
2. Two specimens (PAN[1] 4781, 4782) cited under *Lygodium flexuosum* (L.) Sw. (Bir & Vasudeva 1971, p. 176) really belong to *L. japonicum* (Thunb.) Sw. and are possibly of cultivated origin.
3. *Adiantum lunulatum* Burm. (= *A. philippense* L.) Specimen PAN 4828 Coll. Bir (Motor road, 600 m. on shaded moist rocks) may be an escape from cultivation since it was not collected again from the area.
4. *Cheilanthes bullosa* Kunze, Linnaea *24*: 274.1851; Bedd. Ferns S. India t. 192. 1864; Nayar, Bull. nat. Gdns. Lucknow *68*: 27.1962.
   Specimens: PAN 4518, 4519 Coll. Bir and PAN 5765, 5766 Coll. Vasudeva 55.

Earlier (Bir & Vasudeva 1971, p. 177) recorded as *C. chrysophylla* Hook. Omit reference to Mehra & Bir (1964, p. 109).

5. *Mecodium javanicum* (Spreng) Copel. (*Hymenophyllum javanicum* Spreng).
   Specimen: PAN 4788 Coll. Bir (Shembaganur, 1800 m. on shaded rock). May be an escape from cultivation because it was not found again in 1966 and 1975 excursions.
6. *Doryopteris concolor* (Langsd. & Fish) Kuhn in V. Decken Reissen Ostafr. *313*: 19. 1879.
   Earlier recorded as *Pellaea geraniaefolia* (Raddi) Fée by Bir and Vasudeva (1971).
7. *Lindsaya odorata* Roxb., Calc. J. Nat. Hist. *4*: 511.1846; Kramer, Blumea *15*: 567. 1968; Gdns. Bull. Singapore *26*: 40.1972.
   Specimens: PAN 4501, 4502 Coll. Bir and PAN 5782, 5783 Coll. Vasudeva 74.

Earlier recorded as *L. cultrata* (Willd.) Swartz. in Bir & Vasudeva (1971). Omit reference to Mehra & Bir (1964, p. 118). The Kodaikanal specimens belong to var. *odorata* and are quite variable in size, from 10-50 cm depending upon the habitat.

8. South Indian (from Kodaikanal) specimens of *Dicranopteris linearis* (Burm.) Underwood belong to var. *sebastiana* Panigrahi & Dixit (1971).
9. *Pseudophegopteris pyrrhorhachis* (Kunze) Ching, Acta Phytotax. Sinica *8*: 315. 1963. *Polypodium paludosum* Bedd., Ferns S. India t. 168.1864 (non Blume).

Earlier recorded as *Thelypteris brunnea* Ching (Bir & Vasudeva 1971, p. 187).

10. *Stegnogramma pozoi* (Lagasca) Iwatsuki, Acta Phytotax Geobot. *19*: 124.1963; Holtt., Jour. South Afr. Bot. *40*: 149. 1974.

Earlier recorded as *Leptogramma totta* J.

[1] Abbreviation for Herbarium, Punjab University, Chandigarh, India.

Smith (Bir & Vasudeva 1971, p. 188).

11. *Christella parasitica* (L.) Lév., Fl. Kouy-tchéou: 475.1915; Holtt., Kew Bull. *31*: 309.1976. *Nephrodium procurrens* (Mett.) Bak., Syn. Fil. 290.1867; Bedd., Handb. Suppl. 67.1892 (pro parte). *Nephrodium molle* var. *didymosorum* (Parish ex Bedd.) Bedd., Handb. 279.1883.

Earlier recorded as *Cyclosorus parasiticus* (L.) Farwell (Bir & Vasudeva 1971, p. 188).

12. *Christella dentata* (Forsk.) Brownsey & Jermy, Brit. Fern Gaz. *10*: 338. 1973; Holtt., Jour. S. Afri. Bot. *40*: 143.1974; Kew Bull. *31*: 314.1976. *Cyclosorus sub-pubescens* sensu Holtt., Rev. Fl. Malaya *2*: 273. t. 24. t. 157.1955 (non Blume).

Earlier recorded as *Cyclosorus dentatus* (Forsk.) Ching (Bir & Vasudeva 1971, p. 188).

13. *Cyclosorus interruptus* (Willd.) H.I. to, Bot. Mag. Tokyo *51*: 714.1937. *Nephrodium unitumi* quod. Bedd., Handb. 268. 1883.

Earlier recorded as *C. gongilodes* (Schkuhr) Link (Bir & Vasudeva 1971, p. 188).

14. *Sphaerostephanos arbuscula* (Willd.) Holtt., Jour. S. Afr. Bot. *40*: 164. 1974. Earlier recorded as *Cyclosorus arbusculus* (Willd.) Ching (Bir & Vasudeva 1971, p. 188).

15. *Pseudocyclosorus tylodes* (Kunze) Ching, Acta Phytotax. Sinica *8*: 324.1963 (*xylodes* as an error). *Nephrodium octhodes* var. *xylodes* Bedd., Handb. 240.1883. *Nephrodium xylodes* (Kunze) Hope, J. Bombay nat. Hist. Soc. *14*: 724.1903.

Earlier recorded as *Thelypteris xylodes* (Kunze) Ching (Bir & Vasudeva 1971, p. 187).

16. *Pseudocyclosorus ochthodes* (Kunze) Holttum in Nayar & Kaur Companion to Bedd. Handb. 204.1974. *Thelypteris ochthodes* (Kze.) Ching. Bull. Fan Mem. Inst. Biol. Bot. *6*: 300.1936.
Specimens: PAN 4491, 4494 Coll. Bir; PAN 5838, 5839 Coll. Vasudeva 108. Det. R. E. Holttum.

Earlier recorded as *Thelypteris repens* (Hope) Ching and *T. erubescens* (Wall. ex Hook.) Ching by Bir & Vasudeva (1971, p. 187). Omit reference to Mehra & Bir (1964).

16A. *Thelypteris* sp.
Specimen: PAN 4709 (Observatory hill road, 2100 m.) is not *T. beddomei* (Bak.) Ching as reported earlier (Bir & Vasudeva 1971, p. 187) and might be a hybrid.

17. *Phanerophlebia caryotidea* (Wall. ex. Hook. & Grev.) Copel. Gen. Fil. 111.1947. *Cyrtomium falcatum* var. *caryotideum* (Wall.) Bedd., Ferns S. India t. 119.1864.

Earlier recorded as *Cyrtomium caryotideum* Presl (Bir & Vasudeva 1971, p. 183).

18. *Dryopteris approximata* Sledge, Bull. Brit. Mus. nat. Hist. Bot. *5*: 11.1973.
Specimens: PAN 5855, 5856 Coll. Vasudeva, 96.

Earlier recorded as *Dryopteris ramosa* (Hope), C. Chr. by Bir & Vasudeva (1971, p. 184). Exclude synonym *Nephrodium ramosum* Hope.

19. *Arachniodes conifolia* (Moore) Ching, Acta Bot. Sinica *50*: 153. 1960.
Specimens: PAN 5844, 5845 Coll. Vasudeva 68.

Not *A. speciosa* (Don) Ching as earlier recorded by Bir & Vasudeva (1971, p. 183). Omit reference to Mehra & Bir (1964).

20. *Elaphoglossum stelligerum* (Wall. ex Bak.) Moore ex Alston & Bonner, Candollea *15*: 216.1956; Sledge, Bull. Brit. Mus. Nat. Hist. Bot. *4*: 92.1967.
Specimens: PAN 4814, 4815 Coll. Bir; PAN 5842, 5843 Coll. Vasudeva 141.

Earlier recorded as *E. petiolatum* (Sw.)

Urban and *E. conforme* (Sw.) Schott. (Bir & Vasudeva 1971, p. 184). Omit *E. viscosum* Schott as Synonym.

21. *E. angulatum* (Bl.) Moore Index Fil. 5.1857; Sledge, Bull. Brit. Mus. nat. Hist. Bot. *2*: 83.1967.

Specimens: PAN 5840, 5841 Coll. Vasudeva 147.

Earlier recorded as *E. laurifolim* (Thouars) Moore (Bir & Vasudeva 1971, p. 183). Out reference to Mehra & Bir (1964).

22. *Dryoathyrium boryanum* (Willd.) Ching, Bull. Fan Mem. Inst. Biol. Bot. *11*: 81. 1941; Sledge, Bull Brit. Mus. Nat. Hist. Bot. *2*: 282. Pl. 30.t.1.1962.

Grows in a shola below Palni ghat road, 1400 m. altitude. Few individuals were seen only in this locality. Based on collections made in February, 1975 (PUN[2] 2073-2076 Coll. Vasudeva 1185).

23. *Athyrium pectinatum* (Wall.) Presl *Specimen*: PAN 4790 Coll. Bir (Lake, 2, 100 m.) is a North Indian (Himalayan) species and must be an escape from cultivation.

24. *Asplenium formosum* Willd. in Linn. Spec. Plant ed. 4, 5: 329. 1810; Sledge, Bull. Brit. Mus. nat. Hist. Bot. *3*: 243. 1965.

Abundant on humus covered mountain slopes only in the forest near Bear Shola, 2150 m. Collected in January, 1975 (PUN 2130-2133 Coll. Vasudeva 1149).

25. *Pyrrosia stictica* (Kunze) Holttum, Novit. Bot. Inst. Bot. Univ. Carol. Prague 31. 1968. *Polypodium porosum* Wall., Cat. no. 266.1828 (nom. nud.).

Specimens: PAN 4820, 4821 Coll. Bir: PAN 5869, 5870 Coll. Vasudeva 75.

Earlier reported as *Pyrrosia mollis* (Kze.) Ching (Bir & Vasudeva 1971, p. 192).

In this species ventral hairs are with crisped arms unlike *P. mollis* in which hairs are uniform with straight arms.

ACKNOWLEDGEMENTS

We are extremely thankful to Dr. Frances M. Jarret and Prof. R. E. Holttum (Kew) for expert advice on identifications and taxonomic matters.

S. S. BIR
S. M. VASUDEVA

DEPT. OF BOTANY,
PUNJABI UNIVERSITY,
PATIALA-147 002,
May 16, 1978.

REFERENCES

BIR, S. S. & VASUDEVA, S. M. (1971): Pteridophytic flora of Kodaikanal. *J. Bombay nat. Hist. Soc. 68*: 169-195.

MEHRA, P. N. & BIR, S. S. (1964): Pteridophytic flora of Darjeeling and Sikkim Himalayas. *Res. Bull. Panjab Univ. Sci. (H.S.) 15*: 69-182.

PANIGRAHI, G. & DIXIT, R. D. (1971): Two new varieties of *Dicranopteris linearis* (Burm.) Underw. from India. *Bull. Bot. Surv. India 13*: 162-163.

[2] Abbreviation for Herbarium, Punjabi University, Patiala-147 002, India as included "Index Herbariorum", 1974 ed.

35. *PRIMULA GLABRA* KLATT—A NEW RECORD FOR ASSAM

(*With a text-figure*)

During the study and critical scrutiny of the materials of *Primula* L. of the Eastern Himalaya with special reference to Assam Himalaya, we came across some specimens of an interesting taxon which have been identified as *Primula glabra* Klatt, and confirmed by comparision with the type material deposited in Herb. (CAL). A perusal through earlier and recent literature (Hooker, 1882; Pax 1889; Pax and Kunth 1905; Smith and Fletcher 1944) reveals that the species in distributed over Sikkim, Bhutan, Nepal and adjoining parts of Tibet. The present finding appears to be a new record for Assam. As the Flora of Assam (Kanjilal *et al.* 1930)[1] lacks information, it has been felt necessary to give an illustrated account of the taxon.

Primula glabra Klatt in Linnaea. 37: 500. 1872; Watt in Jour. Linn. Soc. Bot. 20: 7. t. 4B. 1882; Hook. f. in Fl. Brit. Ind. 3: 487. 1882; Pax in Engl. Bot. Jahrb. 10: 193. 1889; Pax & Kunth in Engl. Pflangenr. Primulaceae 42: 92. 1905; Watt in Journ. Roy Hort. Soc. 29: 298, 302, 306, 1904; Craib, ibid. 39: 187. 1913; Watt, ibid. 39; 199, 204, 206, fig. 93, 1913; W.W. Sm. and Forrest, ibid. 54; 14, 31, 33. 1929 and in Notes Roy Bot. Gard. Edin. 16: 24. 1928; W. W. Sm. and Fletcher in Tran. Roy. Soc. Edin. 61: Pt. 1 (1): 47-48. 1944.

Primula glabra Klatt
(Fig. 1)

A small plant of 7-12 cm long and with stout rhizome, leaves compact, rosette, 1-3 cm. × 4-10 mm., spathulate to oblong spathulate, rounded or obtuse apex, serrate to denticulate, glabrous, efarinose, base narrowed into a broad or slender petiole; scape 2-11 cm long, efarinose, apex carrying an umbel of usually 7-10 flowers; bracts 1-2 mm. long, glabrous; Pedices usually 2-3 mm. long, glabrous; Calyx 3-4 mm. long, campanulate, minutely glandular pubescent, 1/3 to 1/2 free, lobes oblong, rounded apex; corolla pinkish, tube slightly exceeds to calyx tube; limb 5-6 mm. diam., annulate, lobe obovate, deeply emarginate; stamens reaching almost the annulus, anthers 1 mm. long, oblong; style 2.5 mm-3.5 mm. long, stigma capitate; capsule

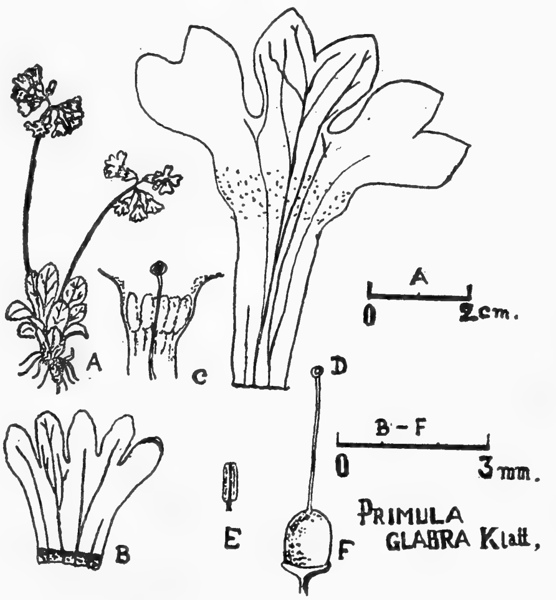


Fig. 1. *Primula glabra* Klatt: A. Habit of the plant; B. Calyx split open; C. An open flower in part showing stamens and a pistil; D. Corolla split open showing lobes of petals; E. Stamen; F. A carpel.

[1] KANJILAL, U. C. *et al.* (1930): Flora of Assam. Vol. III. Prabasi Press, Calcutta.

nearly as calyx oblong, included, seeds rounded to oval-angular.

Distribution: Nepal, Sikkim, Bhutan, Tibet.

Materials examined: SIKKIM. Reg. Alp. alt. 13-1400 ft *Hooker* 10 (ISOTYPE-CAL); Kapoor, alt. 13,000 ft. Dt. 12-7-1910. *W. W. Sm* 3405; Pey keiong La, June 1887. Dr. King's Collector. s.n. Acc. No. 272329 (CAL); Jongri, alt. 12-14,000 ft. dt. 1881. *G. Watt* 5414: NEFA. Kameng Dist. alt. 10,000. dt. 28-5-57. *R. S. Rao* 7894 (B.S.I. Shillong); Se La alt. 4300 dt. 1st. September, 1964, *J. Joseph* 40201 (B.S.I. Shillong).

CENTRAL NATIONAL HERBARIUM,
CALCUTTA.
INDIAN BOTANIC GARDEN,
CALCUTTA.
May 20, 1978.

R. B. GHOSH

G. G. MAITY

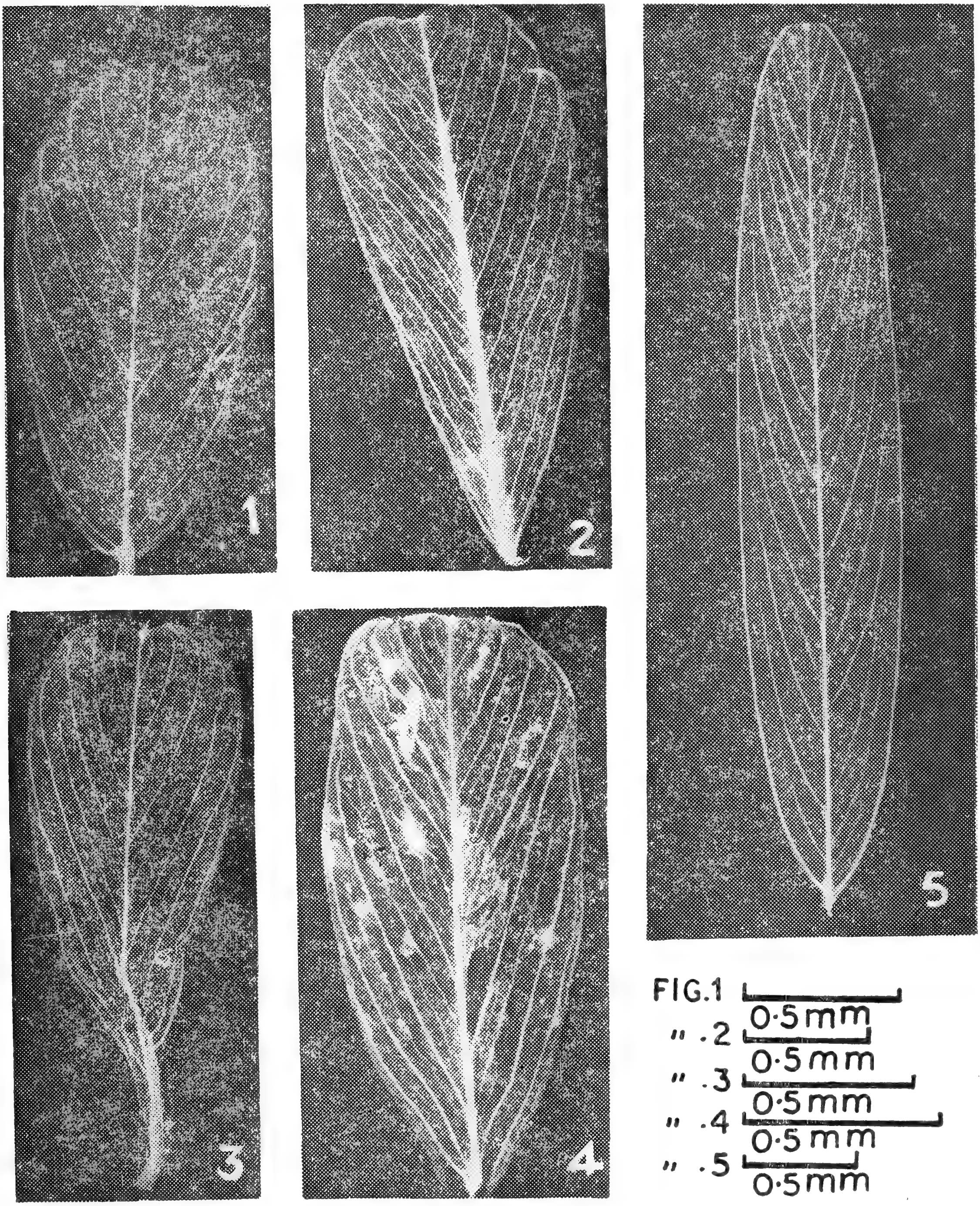
36. FURTHER NOTES ON THE IDENTIFICATION OF THE GENUS *TEPHROSIA* PERS.

(*With seven text-figures*)

In an earlier volume of the *journal*, Mukherjee and Gupta (1970) have described an easy way of distinguishing species of *Tephrosia* from those of other genera, like *Indigofera* in the field, when not in flowering stage. By pulling apart the leaflets, after holding them at their bases and tips, the leaflets of *Tephrosia* species always show a V-shaped cut (Fig. 6A), while *Indigofera* leaflets when similarly pulled show a more or less straight cut (Fig. 7A). With a view to find the reasons for such a differentiating feature, we studied the leaves of several species of *Tephrosia* and *Indigofera*.

The leaflets of both species were decolourized by keeping in a weak solution of KOH for some days and later stained with alcoholic saffranin, dehydrated and mounted in D.P.X. All the slides thus prepared, showed the type of venation characteristic of leaflets of both the genera.

Tephrosia leaflets have a strong mid-rib and from it secondary branches, almost in pairs, are given out to the wings of the lamina at an acute angle (Figs. 1 to 5). In some cases, when they near the margin they show a fork. One of the arms of the fork when it reaches near the margin curves towards the apex, is thicker than the other which becomes slender and later disappears in the thin mesophyll parenchyma (Figs. 2, 3 & 4). The successive pairs of these secondary veins enclose very little strips of thin walled tissue. When these leaflets were pulled apart as said in the beginning, the thin walled tissues in between the lateral veins give way, leaving these veins as they are. This results in the formation of a V-shaped cut (Fig. 6A). On the other hand, the leaflets of *Indigofera* have a uniform pattern of secondary veins, in that the secondary veins depart from the mid-rib more or less at right angles while entering the wings of the lamina. Moreover, these are comparatively thinner. This thinner pattern of venation might be the cause of the straight cut seen when the



Figs. 1—5. Show cleared leaflets of *Tephrosia*. 1. *Tephrosia pauciflora* Wall.; 2. *T. purpurea* Pers.; 3. *T. apollina* Link.; 4. *T. coccinea* Wall.; 5. *T. tenuis* Wall.

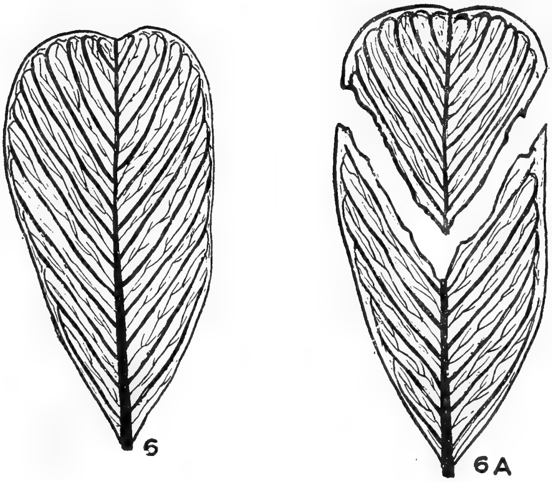


Fig. 6 and 6A. Show leaflet of *Tephrosia* Pers. entire and torn respectively.

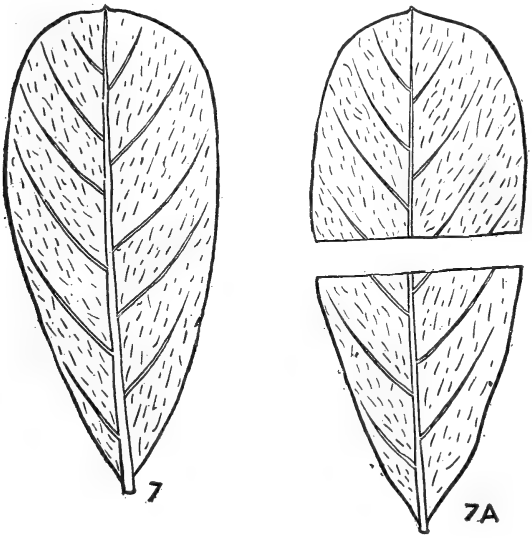


Fig. 7 and 7A. Show leaflet of *Indigofera* Linn. entire and torn respectively.

leaflets were pulled apart (Fig. 7A).

In this connection, it is interesting to mention what has been written in ancient Sanskrit Scriptures on Indian System of Medicine. (*Ayurveda*). Since *Tephrosia* has a great medicinal value in the Indian System of Medicine (Acharya & Kudatarkar Shastri) they describe a simple clue to separate *Tephrosia* leaves from other similar leaves in the fields. It states "When the leaves of *Tephrosia* are pulled apart, the torn region gives an appearance of a tail of an arrow" (*Sharapunkhi*). After carrying out this simple test on leaves to confirm *Tephrosia,* it should be collected and then processed and used against worms etc. (Antihelmin). A similar reference is also given by Acharya in his works. Both these mention the plants' use against liver troubles and Kirtikar & Basu (1935) emphasise its cathartic properties. It is well known that both the plants can be used as cover crops and also as green manure.

In conclusion, it may be stated, that the old Ayurvedic System knew the field identification of *Tephrosia*. The anatomical observations stated above, clearly show that the venation pattern itself is the cause for the peculiar tearing of the leaflets of the genus *Tephrosia*.

We wish to thank the Director, Institute of Science, Bombay, for facilities, Shri A. M. Siddiqui for photographic work. We are also grateful to the Director, M.A.C.S. Poona and the Regional Botanist, Botanical Survey of India (Western Circle, Poona) for sparing some material for this work.

S. S. KELKAR
C. S. LATTOO

DEPARTMENT OF BOTANY,
INSTITUTE OF SCIENCE,
BOMBAY 400 032,
August 28, 1978.

References

ACHARYA, Y. T.: Dravyaguna Vidyanum. pp. 174, No. 113.

KIRTIKAR AND BASU (1935): Indian Medicinal Plants. *1*: 723.

KUDATARKAR SHASTRI, M. N.: Dravyaguna Shastra with Bhavaprakasha Nighantu, pp. 408, No. 242.

MUKHERJEE, P. K. AND GUPTA, RITA (1970): Field Identification of *Tephrosia* Pers. *J. Bombay nat. Hist. Soc. 67* (1): 135.

ADDENDA

Vol. 75 : Supplement

Nectar-feeding adaptations of Flowerbirds

Insert on p. 1047 at the end,

REFERENCES

ALI, SALIM A. (1931): The role of the sunbirds and the flowerpeckers in the propagation and distribution of the tree-parasite, *Loranthus longiflorus* Dest., in the Konkan. *J. Bombay nat. Hist. Soc. 35*: 144.

———— (1932): Flower-birds and Bird-flowers in India. ibid. *35*: 574.

BEDDARD, F. E. (1891): Notes on the structure of the tongue in the family Zosteropidae. *Ibis*: 510-512.

BEECHER, WILLIAM J. (1953): Phylogeny of Oscines. *Auk 70*: 270-333.

GADOW, HANS (1883): On the Suctorial Apparatus of the Tenuirostres. *Proc. Zool. Soc. London 1883*: 62-69.

GARDNER, LEON L. (1927): On the Tongue in Birds. *Ibis* (XII series), Vol. iii, pp. 185-196.

LUCAS, F. A. (1897): The tongue of Birds. Rept. of U.S. National Museum for 1895: 1003-1020.

MOLLER, W. (1930): Uber die Schnabel and Zengenmechanic blutenbesuchender Vogel I Ein Beitrag Zur Biologie des Blumen Vogels. *Biol. Generalis Widen 6*: 651-726.

———— (1931): Uber die Schnabel and Zungenmechanic bluntenbesuchender Vogel II. ibid. *7*: 99-154.

SCHARNKE, H. (1930): Ueber den Bau der Kolibrizunge. *Orn. Monatsb. Berlin 38*: 150-151.

———— (1931): Die Nectarauf nahme mit der Kolibrizunge. ibid. *39*: 79.

———— (1932): Ueber den Bau der Zunge der Nectariniidae, Promeropidae and Drepanididae nebst Bemerkunge zur systamatik der blutenbesuchender Passers. *J. Orn. Berlin 80*: 114-123.

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater, 4th edition (reprint). 28 plates in colour by Paul Barruel and many other monochrome illustrations. Rs. 60.00
(*Price to members Rs.* 55)

The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett. Rs. 10

Birds

The Book of Indian Birds, by Sálim Ali. 11th (revised) edition. 74 coloured and many monochrome plates. Rs. 60.00
(*Price to members Rs.* 55)

Checklist of the Birds of Maharashtra, by Humayun Abdulali. Rs. 2.50
(*Price to members Rs.* 2)

Checklist of the Birds of Delhi, Agra and Bharatpur, by Humayun Abdulali & J. D. Panday. Rs. 3.00

Snakes

Identification of Poisonous Snakes, Wall chart in Gujarati, and Marathi. Rs. 5

Plants

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 3rd edition (Reprint). Rs. 40.00
(*Price to members Rs.* 35)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. 2nd edition. (*in Press*)

Miscellaneous

Glimpses of Nature Series Booklets :

1. Our Birds I (with 8 coloured plates) in Kannada Rs. 0.62
2. Our Beautiful Trees (with 8 coloured plates) in Hindi Rs. 0.62
3. Our Monsoon Plants (with 8 coloured plates) in Hondi and Marathi. Rs. 0.80
4. Our Animals (with 8 coloured plates) in English, Gujarati, and Hindi Rs. 1.25

Glimpses of Nature in India (with 40 coloured plates) in English Rs. 7.50
(*Price to members Rs.* 5)

Back numbers of the Society's Journal. Rates on application.

The Society will gratefully accept back numbers of the *Journal*, from members who may not wish to preserve them.

TERMS OF MEMBERSHIP

Entrance Fees :

Ordinary and Life Members	**Rs. 25**
Student Members	Rs. 10

Subscription :

(*a*) Ordinary individual Members	Rs. 50
(*b*) Ordinary Corporate Members	Rs. 100
(*c*) Ordinary Members resident outside India	Rs. 85
Life Members	Rs. 750
	(Rs. 250 after 20 years)
Compound Corporate Members	Rs. 1500
Student Members (without Journal)	Rs. 10
Annual subscription to Journal	Rs. 105

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £ 5.50 should be paid annually to the Society's London Bankers—The Grindlays Bank Ltd., 23 Fenchurch Street, London EC3P. 3ED. Account No. 1101091.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

Regd. No. RN 5685/57.

PAGE

CONTENTS

Printed by Bro. Leo at St. Francis Industrial Training Institute, Borivli, Bombay 400 092 and published by Editors: J. C. Daniel, P. V. Bole and A. N. D. Nanavati for Bombay Natural History Society, Hornbill House, Shahid Bhagat Singh Road, Bombay 400 023.